THE annual volume of Papers of the Michigan Academy of Science, Arts and Letters is issued under the joint direction of the Council of the Academy and of the Executive Board of the Graduate School of the University of Michigan The editor for the Academy is Paul S Welch, for the University Eugene S McCartney

Previous publications of The Michigan Academy of Science, now known as The Michigan Academy of Science, Arts and Letters, were issued under the title, Annual Report of the Michigan Academy of Science Twenty-two volumes were published, of which those numbered 1 21 and 22 are out of print Copies of the other volumes are still available for distribution and will be sent on exchange so long as the editions last Applications for copies should be addressed to the Librarian of the University of Michigan

Annual Reports embracing the proceedings of the Academy will, however, continue to be published Applications for copies should be addressed to the Librarian of the University of Michigan

MICHIGAN ACADEMY OF SCIENCE, ARTS AND LETTERS

VOLUME IV

PART I

CONTAINING PAPERS SUBMITTED AT THE ANNUAL MEETING IN 1924

THE MACMILLAN COMPANY
NEW YORK BOSTON CHICAGO
ATLANTA SAN FRANCISCO

MACMILLAN & CO LIMITED
LONDON BOMBAY CALCUTTA
MELBOURNE

THE MACMILLAN CO OF CANADA, LTD
TORONTO

PAPERS

OF THE

MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

EDITORS

PAUL S WELCH

UNIVERSITY OF MICHIGAN

EUGENE S McCARTNEY

UNIVERSITY OF MICHIGAN

New York

THE MACMILLAN COMPANY

LONDON MACMILLAN & COMPANY, Limited

1925

Set up and printed,
February, 1925

PRINTED IN THE UNITED STATES OF AMERICA

OFFICERS FOR 1924

President
CAMPBELL BONNER, Ann Arbor

Vice-Presidents
ANTHROPOLOGY, H H Bartlett, Ann Arbor
BOTANY, R P Hibbard, East Lansing
ECONOMICS, C E Griffin, Ann Arbor
LANGUAGE AND LITERATURE, J W Scholl, Ann Arbor
GEOLOGY AND MINERALOGY, Helen Martin, Tulsa, Okla
HISTORY AND POLITICAL SCIENCE, E S Brown, Ann Arbor
MATHEMATICS, T H Hildebrandt, Ann Arbor
PSYCHOLOGY, H F Adams, Ann Arbor
SANITARY AND MEDICAL SCIENCE, Philip Hadley, Ann Arbor
ZOÖLOGY, L R Dice, Ann Arbor

Secretary-Treasurer
L R DICE, Ann Arbor

Librarian
W W BISHOP, Ann Arbor

Editor
P S WELCH, Ann Arbor

DATES OF PUBLICATION OF PREVIOUS VOLUMES

VOL I April 26, 1923

VOL II Jan 18, 1924

VOL III March 15, 1924

CONTENTS

ANTHROPOLOGY

BOTANY

GEOLOGY

ILLUSTRATIONS

PLATES

TEXT FIGURES

MAPS

THE MISSAUKEE PRESERVE AND RIFLE RIVER FORTS

W B HINSDALE

WIDELY distributed throughout the country are evidences that man has busied himself, at times, by enclosing open spaces with banks of earth Some of the inclosures bear evidence of considerable age They may be as old as the oldest mounds Mounds are situated inside some of them Others were built since the Discovery and are matters of historic record Many of these earthworks are imposing in proportions, having banks from twenty to thirty feet high The largest inclosure in the United States is that called Fort Ancient, in Warren County, Ohio The distance around the crest of the irregular walls of Fort Ancient is nearly three miles The space enclosed aggregates about one hundred acres The height from bottom of the moat to crest is over twenty-five feet in many places

The Indians of Michigan never undertook any such stupendous enterprise as Fort Ancient There were, however, many inclosures of striking appearance and outline in this state Inclosures are usually referred to as "forts," on the supposition that they could have been built for no other purpose than that of defense There were at least two distinct patterns of forts One type had curved walls, forming elliptical or curved spaces The other type had nearly straight lines and sharp angles outlining irregular polygons One might say that the two types are so different as to belong to quite different cultural conceptions

A large number of our forts, like the garden beds, have been plowed down or mutilated beyond recognition In an archeological survey of the state the remaining works of this character should receive first attention They should be accurately

located, measured, pictured, plotted and charted We can give an approximately accurate description of one or two groups of the forts as they are today

MISSAUKEE PRESERVE

In the summer of 1923 an interested and enterprising gentleman gave the University of Michigan a tract of one hundred and twenty acres, situated in Aetna Township, Missaukee County, Section 14, in which two well-preserved inclosures are to be found A few rough measurements have been made of them Number 1 is nearly circular, 161 feet in diameter In some places the wall is 7 feet high from the bottom of the circumscribing ditch or moat upon the outside The banks are well preserved and are nowhere lower than two or three feet above the inside level, though, of course, badly weathered and washed The age of Number 1 can be inferred from the description of Number 2, for they all appear to have been made about the same time Fort Number 2 upon this tract is situated about thirty rods from Number 1 It is larger and is elliptical in shape The long diameter is 180 feet, the short diameter is 136 feet The earthwork is of the same character in the two inclosures The moat around this second fort is, in places, four feet deep The height of the walls of the two forts is about the same There is a gateway upon the north side of each Number 1 has also a gateway opening towards the northeast The second gateway of Number 2 opens towards the southwest The two openings or gateways of each are four or five feet wide There is a pine stump standing upon the crest of the wall upon the east side which is 47 inches in diameter inside the bark The number of annular rings per inch is ten or twelve There are stumps nearly as large as this standing inside the inclosure. It has been fifty years, probably, since the trees were cut From this it is fairly safe to estimate that at least two hundred and fifty years have elapsed since the forts were abandoned How long it had been abandoned before this particular tree began to grow is, of course, purely conjectural

The same is true of the duration of the fort's occupation and the time of its construction

The fact that the surface within the inclosures was strewn with hundreds of pottery fragments leads to the conjecture that it was occupied for a considerable time Many small sherds may be picked up there now, though it would appear that all relics which might give important clues have been taken away Pipes, whole pottery vessels, and other interesting artifacts are reported to have been found in or near the forts A small mound near by also yielded a skeleton and artifacts

These interesting inclosures are now, almost too late, rescued by purchase from further spoliation, to be available for scientific scrutiny when opportunity occurs It remains to make careful surveys of them and to determine, if possible, whether the banks were ever palisaded, as were some similar structures elsewhere located The molds of decayed posts may be found as evidence that they were defenses against enemies with their walls heightened by a sort of post-fence upon top If the evidence in favor of fortification does not become reasonably convincing after careful investigation, other guesses as to the purpose to which they may have been put will be mentioned in speaking of the forts upon Rifle River in Ogemaw County There is much similarity between the two groups of inclosures

There is no stream or body of water within several miles of this inclosure except a small rivulet a hundred rods away Near Fort Number 2 there is a spring which, when the forest was standing, must have been perennial It was trickling into a pool about thirty feet across in early summer, by late summer the pool was dried up There are other small springs upon the tract

The two forts are not upon an eminence, but from a quarter to a half mile away there is a range of low, gravelly hills skirting the area upon all sides It will be recalled that the entire country, parts of which we are describing, is of glacial drift

THE RIFLE RIVER FORTS

Directly east from the Missaukee Preserve, across Roscommon County, lies Ogemaw County Through the center of Ogemaw County flows Rifle River, a tributary of Saginaw Bay As one crosses Roscommon County he hears of mounds, forts, graves, relics, etc , all of which come within the scope of the state archeological survey, when made At the crossing of one of the main roads, ten miles east of West Branch and the Rifle River, is the hamlet of Selkirk in the township of Churchill Churchill is in the same tier of townships as Aetna, in Missaukee County, forty miles away

Within a mile and a half of Selkirk are four inclosures, two north, or up the river, the other two down the river This location is northwest from the north shore of Saginaw Bay It is about fifteen miles from the southeast corner of Ogemaw County to the northwest shore of the bay Iosco County lies between Ogemaw and the shore of Lake Huron Churchill is the sixth township west of the Huron shore

In the Twelth Report of the Bureau of Ethnology, 1890–1891, an account is given by Cyrus Thomas of the *Rifle River Forts, Michigan* In Smithsonian Report, 1884, is an article by Mr M L Leach entitled, *Ancient Forts in Ogemaw County, Michigan* In a leaflet by Mr Harlan I Smith reference is made to the "works" Since the publications referred to, no references to the Ogemaw "forts," excepting those borrowed from the older records, have come to the attention of the writer, although for twenty-five years lookout has been kept for more recent information

The staff of the University Museum has for some time contemplated a visit to the Ogemaw district, being in doubt whether the inclosures had not met the usual fate of the greater number of the state's immovable antiquities On July 28, 1923, a party visited the Rifle River Valley for the purpose of obtaining first-hand information, with the ultimate object in view of having thorough investigations made, hoping thereby that some of the secrets of the situation may be cleared up and, proportionately, conjectures reduced to lower terms

The range of counties of which Ogemaw is one is a typical "chopped over" and "burnt over" district of north central Michigan The Rifle River is a beautiful clear-water stream of rapid descent over a cobble-stone bottom Originally it abounded in trout and such other fish as thrive in cool, clear eddies and occasional deep places The dense forest was mostly pine, of excellent quality The land surface is undulating with gravelly or sandy soil and glacial boulders are plentiful There are many fine lakes found within the county, but none are nearer than six or seven miles

Swamps are not large or common in the vicinity For the most part the river bank is firm, with an occasional marshy strip Many springs may be seen trickling from the margins of the low banks Considerable of the land has lapsed to the state on account of delinquent taxes as it is of very poor quality, a great part of it is unenclosed and not worth the fencing Occasionally, a productive farm is to be observed and a great many unproductive ones are occupied by rugged farmers, many of whom were at one time "lumber-jacks"

Reference is made in the report of Mr Thomas to "five enclosures commonly known as 'Indian Forts,' three on the east side and two on the west side of the river" We were unable to locate more than four and believe the report to be in error in this regard, although at a distance of fifteen miles west of southwest is an authenticated crescent whose exact location is in the center of the boundary between Sections 33 and 34, West Branch Township It is presumably the Hauptmann work described in the old record It is not upon a stream of any size Its distance from a small branch of Mansfield Creek is, perhaps, fifty rods

Inclosure Number 1 is well described in the diagram in Mr Thomas' report He states that at the time of his examination the area was heavily timbered with hemlock At present the ground is nearly bare excepting numerous pine stumps upon the walls and within the enclosed space The work itself appears to be in about the same condition as it was when his survey was made Intelligent residents of the neighborhood say

it is somewhat reduced by weathering and by cow-paths Fortunately, the slashing in which this and the three other inclosures are located has never been damaged by cultivation There is the appearance upon the southwest segment of the work of the wall being double, since the steep bluff upon that side drops from the top of the trench quite abruptly for a few feet

The pathways leading from the openings of nearly all the inclosures are quite narrow and consist of the original earth that was not disturbed in digging the trenches Originally, they would, perhaps, permit two persons, walking side by side, to pass along them In one or two places the gateways are as much as twelve feet in width, as Thomas has indicated in regard to Number 1 We were not able to verify the reports as to the number of openings in the inclosures Inclosure Number 2 might have had five, but we were led to think there were only four places for entrance Time and cows' feet have wrought changes Number 2 is the largest of the group, being approximately 300 feet east and west by 280 feet north and south The walls and moat are, for the most part, distinctly traceable For long reaches the wall is seven or eight feet slant height from the top to the bottom of the moat The trenches end abruptly at the gateways Leach, in describing Number 3, indicates eight openings, one for each cardinal and one for each intermediate point of the compass This we were unable to verify, either as to point of numbers or orientation At present but four openings are clearly apparent, one or two of them quite wide Probably, upon the river side of the inclosure, lumbermen, seeking an approach to the river, have graded down for a space of thirty feet The surface inside is rough and uneven with hummocks three to six feet in height Some filling in and tearing down may have been done elsewhere, but such alterations can be detected and restorations can be made with a little skillful attention Upon the whole, the wonder is that all the works are so well preserved

Inclosure Number 4 is horseshoe-shaped, not a completed inclosure It is situated upon the west side of the river and is more like three sides of a rectangle, with an open side of 206

feet facing a narrow swamp lying between it and the stream It has a narrow opening in the southwest corner and also one very near to the northeast corner From the east end of the south wall to the middle of the first opening is 128 feet, from there to the second opening, 110 feet From the second opening to the end of the north wall is 162 feet, making 400 feet of earth construction in all

Inquiry along the Rifle River brought nothing but negative answers as to whether arrows, hammer-stones, celts, axes, copper or pottery had ever been unearthed In almost every locality of the state many residents have a few specimens they have gathered in the fields We were unable to find any specimens about Selkirk or to secure information about those who had them The inclosures of Missaukee County were strewn with pottery fragments The surface within and without the Ogemaw "works" did not disclose a single specimen, although more searching and continued observation may bring some to light No graves or mounds have been reported and much of the land has sometime been worked over to some extent After several hours' search we found in two of the inclosures, an inch or two below the surface, a few pieces of pottery and could, no doubt, have found more, but they are far from common

The works we have been describing are very much like those of western New York and southern Canada, which are attributed to the Iroquois, and it is well known that those Indians made frequent forays into this section, but the specimens of pottery we have obtained are pronounced by competent ceramists to be Algonquian Evidences of pit holes, fire-rings, wigwam sites, were not found, excepting one small pit upon the inner side of bank Number 2 This pit, after considerable search, revealed nothing in the way of evidence as to the purpose for which it was made It will be recalled that near the Missaukee works pits are abundant A number of skeletons have also been exhumed in that neighborhood No finds of this description have been reported from the Rifle River district This lack of finds may be accepted as evidence, though not very convincing, that

the places were not occupied for any great length of time There must have been burials, and artifacts will probably yet be discovered Because of the appearance of the stumpage the Missaukee group and the Rifle River group must have been vacated at about the same time

INCLOSURES IN OTHER PARTS OF THE STATE

The forts of the north-central part of the state are not, by any means, the only ones, but they happen to be the best preserved In Climax Township, Kalamazoo County, was a perfect, elliptical inclosure, with major and minor axes of 330 and 210 feet respectively The walls were three feet high and the surrounding ditch ten or twelve feet wide

Mr Charles Lanman, in *The Red Book of Michigan*, 1871, says "The so-called 'forts' are but seldom met with and are fairly uniformly of small dimensions, the principle ones being in the southeast, along the shores of the Detroit, Huron, and Raisin rivers, and occasionally upon Lake Erie, between the Detroit and Maumee rivers" Upon what evidence he makes this statement is not known, but there is no apparent reason for doubting what he says about the southeastern part of the state, although the visible proof is lacking If the reports, many of them vague, are to be given much credence, the entire state was pretty well "fortified"

Evidently taking Mr Bela Hubbard as his authority, although he does not say so, Lanman reports further "In the county of Wayne, on the north bank of the Detroit River, is a fort of the circular or elliptical kind, with an embankment two or three feet in height and compassing, perhaps, one acre On the east side, as one approaches the fort, there are two parallel embankments of earth, within a few feet of each other, rising four or five feet, and crossing the swamp in a direct line toward the fort"

EARTHWORKS OF IRREGULAR OUTLINE

Works of irregular outline once existed in different parts of the state John T Blois, *Gazetteer of The State of Michigan*,

whom everybody seems to quote as an authority, and from whom Lanman seems to have taken, word for word, his account of the Springwells works, says "In Bruce Township, in Macomb County, on the north fork of the Clinton, are several with ditch on the outside and including from two to ten acres, with entrances which evidently were gateways and a mound on the inside opposite each entrance" He says, further, that near the mouth of the Clinton River there were ancient works, representing a fortress, similar to those in Ohio and Indiana Blois speaks of similar banks of earth near the village of Marshall, Calhoun County, and of others in Kalamazoo County In the third volume, *Michigan Historical Collections*, Mr R B Post describes groups of mounds and inclosures upon Rabbit River, Allegan County The inclosures were, some of them, very close together and none as much as 200 feet across Many of them were quite remote from water and did not show many evidences of having been occupied In the same vicinity were mounds surrounded by circles Many of the numerous mounds of that county had been explored with road-scrapers and horses Such is the method of the relic hunter

One should refer to the report of Mr George H Cannon upon pre-historic forts in Macomb County, *Michigan Pioneer and Historical Collections*, Vol XXXVIII, for a detailed survey of forts in Bruce and Armada townships One encloses an acre, another between one and two acres, and the largest one three acres and a half These works were built in straight lines, making at some corners obtuse angles, at others acute The smallest inclosure had three openings, the others four

There is a record of a peculiar construction upon the north bank of the Raisin River, in the northeast part of the village of Tecumseh, described by Mr John J Adam, *Michigan Pioneer Collections*, Vol II (page 363) "It was laid out in the form of a square and a circle, with an opening from the one to the other where they joined — the trails all leading to and from the circle, and both parts having an embankment of about four feet in height, and having in the center of the circular part a pit five or six feet deep When the white settlers first came here

there were some cedar posts in the outer embankment, and there were evidences of the place being quite often used for meetings or gatherings of some kind " This description would apply very well to some of the works in Ross County, Ohio, and to others found elsewhere in that state

Embankments, circles, squares, breastworks, and other forms of earth construction, not described as mounds, are reported also from Antrim, Branch, Huron, Kalkaska, Keweenaw, Osceola, Saginaw, St Joseph, Sanilac, Tuscola and Wexford counties, but probably not half of them are recorded

CONJECTURES

Many of the "forts" are so small they could not have served as permanent places of abode for many people Villages may have been located within the larger ones, but more likely they were refuges for the people of the outlying districts in time of danger, as suggested by Bushnell, in *Native Villages and Village Sites East of the Mississippi* If the inclosures were forts, which signifies warfare, there must have been two hostile groups in the territory at the same time Whether they were the work of the invaders or the invaded, or both, gives opportunity for more theorizing

There are those who think the inclosures have some ceremonial significance If the inclosures were fortifications, why would they have so many openings? Primitive people were intensely religious and influenced by shamanistic magic, and to perform rites and ceremonies paraphernalia, including such as would shield performances from public gaze, was necessary Temporary and fragile lodges were used for performances To make seclusion more secure and permanent screens of earth might have been constructed, forming a kind of cabinet

The places mentioned should all be measured accurately and sketched with instruments of precision in the hands of competent surveyors It often happens that a closed space appears to the casual observer as being of a pretty definite shape when, in reality, the conception is quite wrong in details The "step-

ping-off," ten-foot pole, and tape-line methods supplemented by guesswork are not very accurate when irregular lines and angles are involved

University of Michigan

AN UNUSUAL TREPHINED SKULL FROM MICHIGAN

W B HINSDALE

YEARS ago a very important mound discovery was made in what was called the Great Mound of the Rouge River, near Detroit The incident is narrated by Mr Henry Gillman in a Smithsonian report for 1875 A number of human skulls taken from the mound had been artificially perforated The apertures varied from less than half an inch to nearly an inch across The holes were round with somewhat flaring edges, some giving evidence of having been bored with a stone point or a flint "drill" Similar specimens were found elsewhere in the eastern part of the state, in the Lake Huron drainage area This culture trait (skull-trephining) centered in places far remote from Michigan, in Mexico and Peru It had its most remote occurrence in Michigan, very few such finds being noted in the Great Lakes districts

Mr Gillman states that the perforations in the skulls he mentions were made after death There is a specimen in the University of Michigan Museum, however, of real trephining (Plate I) The skull is from the Devil River Mound and has a very symmetrical hole in the top of the skull-cap, bored while the person was still living The edges of the opening show unmistakable evidence of a well-advanced healing process, which could have gone on only during life

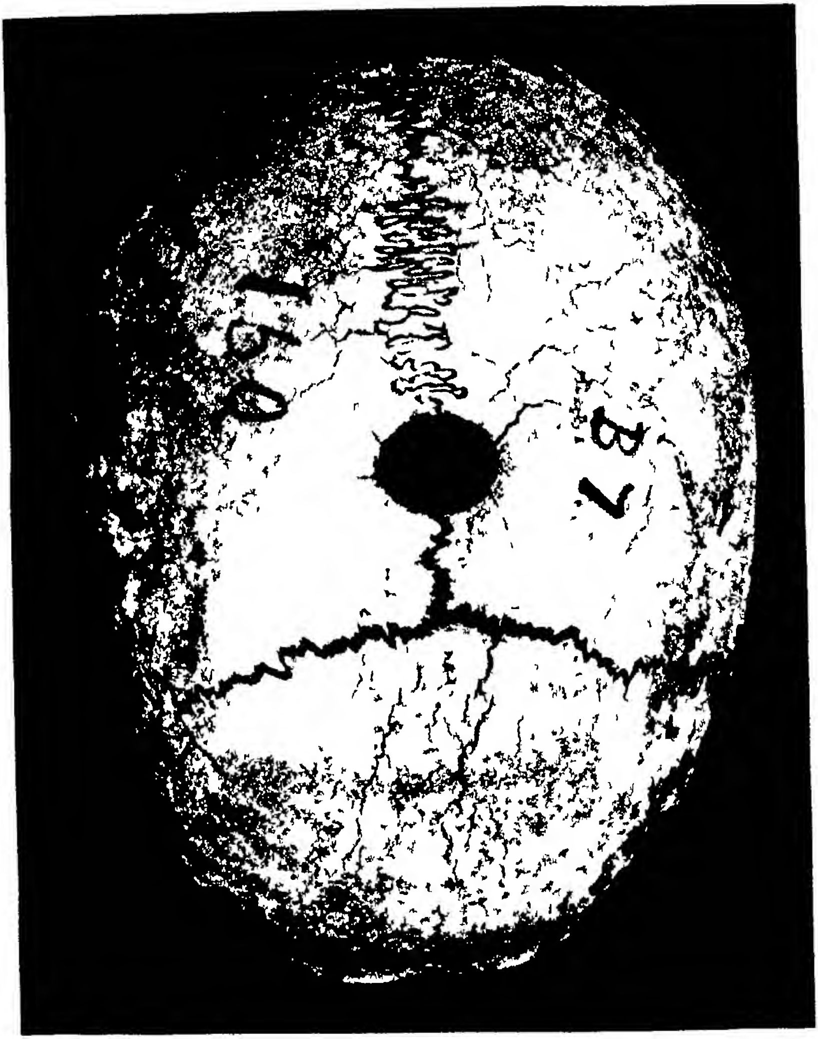
One might ask Why were the skulls perforated? In the majority of specimens the operation was probably performed after, or immediately preceding, death Mr Hrdlicka suggests that the skulls bored after death were so treated for the purpose of securing the "button" as a fetish Some of the heads might have been "operated upon" with a view to removing pieces of

weapons, or for restoring the shape of the head after a severe thump The skull in the Museum, to which reference has been made, shows no evidence of either injury or disease The perforations are usually, in the Michigan specimens, directly in the center of the vertex

The operation may have been performed for some medico-religious reason, to let a bad spirit out or a good spirit in, which, of course, is a wild conjecture The fact remains, however, that perfectly normal skulls were trephined while the subject was still living It is surprising to note in the *Handbook of American Indians*, under "Medicine and Medicine-Men," the statement that "trephining has never been found north of Mexico"

University of Michigan

PLATE I



A Trephined Skull in the Museum of Zoology, University of Michigan

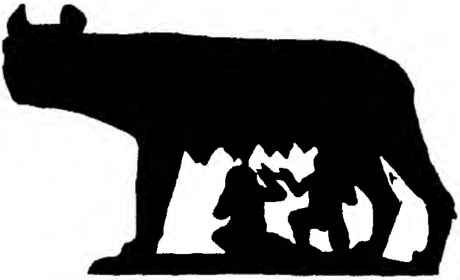


FIG. 1. The Capitoline Wolf

GREEK AND ROMAN LORE OF ANIMAL-NURSED INFANTS

EUGENE S. McCARTNEY

"Come on, poor babe:
Some powerful spirit instruct the kites and ravens
To be thy nurses! Wolves and bears, they say,
Casting their savageness aside, have done
Like offices of pity."

The Winter's Tale, Act II, Scene 3

THE best known classical wonder-tale of animal-nurtured children is that of Romulus and Remus. The story of Cyrus is less prominent chiefly because it is not associated with an event so important as the founding of Rome. In biblical lore the feeding of Elijah [1] is equally miraculous, although it is not an exact parallel. Such tales are, however, not restricted to any time or country.

"Slavonic folk-lore tells of the she-wolf and she-bear that suckled those superhuman twins, Waligora the mountain-roller and Wyrwidab the oak-uprooter; Germany has its legend of Dieterich, called Wolfdieterich from his foster-mother the she-wolf; in India, the episode recurs in the tales of Satavahana and the lioness, and Sing-Baba and the tigress; legend tells of Burta-Chino, the boy who was cast into a lake, and preserved

[1] *I Kings*, xvii, 6.

by a she-wolf to become founder of the Turkish kingdom, and even the savage Yuracarés of Brazil tell of their divine hero Tiri, who was suckled by a jaguar "[2]

Since, however, Greek and Latin are remarkably rich in such legends and are also the oldest literatures which contain a vast body of them, it seems worth while to render them accessible to comparative anthropologists in convenient form There is a monotonous similarity about many of them In order to bring out into relief their general uniformity, I am giving nearly all of them in their barest outlines, in fact almost in the form of a catalogue Readers without special interest in folk-lore and anthropology may feel inclined to skip to the next caption after reading a few illustrations of stories told of mortals

STORIES TOLD OF DEITIES

A number of such stories gathered about the name of Zeus Since his father, Cronus, had been warned by Earth and Sky that his own son would dethrone him, he swallowed his offspring at birth After five children had suffered this fate, Rhea repaired to a cave in Crete, where she gave birth to her sixth child, Zeus She entrusted him to the Curetes and to the nymphs Adrasteia and Ida, and then deceived Cronus by substituting a stone wrapped in swaddling clothes Such is one account of the birth of Zeus[3] In the absence of his mother Zeus was fed and nursed by bees,[4] provided with ambrosia by doves,[5] with nectar by an eagle,[6] and suckled by a goat,[7]

[2] Tylor, *Primitive Culture* (1920), I 282 Tylor gives references to these and other similar stories See also Tylor, *Wild Men and Beast-Children*, *Anthropological Review*, I (1863) 21–32, A H Sayce, *Herodotus, Books I–III*, 68, Gibbon, *Decline and Fall of the Roman Empire*, chap 42, Gubernatis, *Zoölogical, Mythology* (1872), II p 177, Usener, *Die Sintfluthsagen*, pp 110–111, C Plummer, *Vitae Sanctorum Hiberniae*, I (1910), p cxlii, G A Dorsey, *Traditions of the Skidi Pawnee* (*Memoirs of the American Folk-Lore Society*, 1904), p 178 ff

[3] Apollod, *Bibl*, 1 1 5–7 Cf Diod, 5 70 1–3

[4] Ant Lib, 19, Serv *ad Verg*, *Georg*, 4 150 Cf Colum, *De Re Rust*, 9 2 2

[5] Homer, *Odyss*, 12 63, schol *ad loc* Eustath on 12 59 sqq (p 1711), Athenaeus, 11 79–80 Cook, *Zeus*, I 151, figures two coins showing birds

a sow,[8] a cow[9] and perhaps by a sheep[10] (For the sheep, see Plate II, Fig 1)

Another deity, Cybele, the daughter of Dindyme and Macon, a king who reigned in Phrygia and Lydia, was exposed by her father on Mount Cybelus Panthers and other fierce animals nourished the child with their milk until it was rescued by shepherdesses[11] The Phrygians placed statues of panthers and lions beside those of Cybele because it was generally believed that she was suckled by these animals[12] The name of the goddess is said to have been derived from Cybelus[13]

STORIES TOLD OF MORTALS

The story of Habis, grandson of Gargoris, king of the Tartesii, is the most elaborate and diversified of all such accounts that have to do with mortals When the king learned that his daughter had given birth to a natural child, he took measures to have it killed He ordered that it be exposed, but when a number of days later he sent to get the corpse, it was found that the child had been nourished by the milk of wild animals

hovering over the infant Zeus One seems to be a dove and the other an eagle

[6] Moero in Athenaeus, 491 B See also the quotation from Cook in the next note

[7] Aratus, *Phaen*, 163-164, Diod, 5 70 3, Callim *Hymn in Iov*, 49, and schol *ad loc* Ptolem Hephaest, ap Phot, p 473 R, Ovid, *Fast*, 3 431-432, 5 120-121, Strabo, 8 7 5 (p 387), Eustath on Iliad, 9 535 (p 773, 14 ff), Serv on Vergil, *Georg*, 1 205 (cf Serv on *Aen*, 9 665), *Second Vatican Mythographer*, 16 (in G H Bode, *Scriptores Rerum Mythicarum Latini*), Hyg, *Astron*, 2 13, Tert, *Apol*, 25, Porph, *De Abstinentia*, 3 16, Minucius Felix, 21 10

"An autonomous copper struck at Aigion shows Zeus as an infant suckled by the she-goat Amaltheia between two trees with an eagle above him" — Cook, *Zeus*, I Fig 401, p 529 For records of other representations of the goat see *C I L*, VI 26464, 26976,

[8] Athenaeus, 375 F — 376 A See also Cook, *Zeus*, I 653

[9] "At Praisos, an Eteo-Cretan town with a temple of Zeus *Diktaios*, silver coins were struck c 450-400 B C with the obverse type of a cow suckling an infant who has been commonly and rightly identified as Zeus" — Cook, *Zeus*, I 660 See Figures 507-508

[10] See A J Evans, *Journal of Hellenic Studies*, 21 (1901), 129, Fig 17, Cook, *Zeus*, I 401

[11] Diod, 3 58 1-2 [12] *Op cit*, 3 59 8 [13] *Op cit*, 3 58 2

Next he had it put in a narrow path to be trampled to death by herds, but it escaped unharmed and was again nourished by animals Then it was exposed to dogs from which food had been withheld for many days, and finally to pigs, but once more it was suckled To make sure of its destruction the king had it thrown into the ocean, but the waves washed it back to safety [14] and it was suckled by a doe It continued to live among the deer and coursed over mountain and glade with a deer's speed At length it was caught in a net and brought to the king Through his features and the marks branded upon him as a child, he was recognized as the king's grandson His salvation was attributed to the gods and he was restored to the position of prince Later he conferred boons upon his rough subjects by teaching them how to yoke oxen to the plow and to cultivate finer food After a life of usefulness he died, but the kingship remained in his family for many generations [15]

The most famous of all these stories is that of the founders of Rome Romulus and Remus, twin offspring of Rhea Silvia and Mars, were cast adrift in the Tiber by order of their mother's uncle, who wished to destroy all legal heirs to the kingdom he had usurped The little trough in which they were exposed in the overflow of the river was left in a place of safety by the receding waters A wolf that had descended from the hills to drink came upon them and suckled them They were found by a shepherd and reared by him and his wife [16] Prior to their

[14] Cf Frazer, *Folk-Lore in the Old Testament*, II 454 "It has been conjectured that in stories like that of the exposure of the infant Moses on the water we have a reminiscence of an old custom of testing the legitimacy of children by throwing them into the water and leaving them to swim or sink, the infants which swam being accepted as legitimate and those which sank being rejected as bastards" See also p 455 The Psylli, an African tribe, tested legitimacy in a different fashion They exposed children to serpents If they were not injured, they were regarded as legitimate, if they died, they were thought to be bastards — Varro, ap Prisc, 10 32

[15] Justinus, 44 4.

[16] Livy, 1 4, Dionys, 1 79, Plut, *Rom*, 4 and 7, Plut, *Mor*, 314 F — 315 A, 320 D — 321 A (*Parallels*, 36) See also Cic, *In Cat*, 3 19, Cic, *Rep*, 2 4, Verg, *Aen*, 1 275, 8 630, Serv *ad Verg*, *Aen*, 1 273, Ovid, *Fasti*, 2 413, 3 53, Prop, 2 6 20, 3 9 51, 4 1 55, 4 4 54, Hyg, *Fab*, 252, Aur Vict, *Orig Gent Rom*, 20 and 21, Zonaras, *Ann*, 7 1

rescue, however, the bird sacred to Mars, the woodpecker, had brought them morsels of food[17] Such, in its lowest terms, is the story the Romans loved to tell[18] (See Text Fig 1 and Plate II, Fig 2)

Among the many traditions regarding the parentage of the children is one which Plutarch regarded as altogether fabulous According to this version they were the sons of a handmaiden and a phantom Fearful of an oracle which said that the son of a vision and a virgin was destined to become very valorous and successful, Tarchetius, king of the Albans, gave orders to have the twins killed Instead they were left beside the river A wolf came upon them there and gave them suck, while all sorts of birds provided them with food until a cow-herd rescued them[19]

A remarkable parallel to the first version is noted by Plutarch[20] in the case of Lycastus and Parrhasius, twin offspring of Phylonome and Mars Because of her fear of her father the mother threw the children into the river Erymanthus They were driven by the waves to a hollow tree which happened to be the lair of a wolf The animal thrust her whelps into the stream and suckled the children The twins were found and reared by a shepherd

Christian writers frequently mention Romulus and Remus, e g , Tertull , *Apol* , 25, *Ad Nat* , 2 10, Lact , *Div Inst* , 1 20, Min Felix, 25, Hieronym , *Chron* , p 77 (Schoene), Aug , *De Civ Dei*, 18 21

A group-statue of the wolf and twins was erected by the curule aediles in 296 B C (Livy, 10 23) Cicero, *loc cit* , says that there was on the Capitoline in 65 B C a statue of the wolf with the infants gaping at its dugs A bronze statue still exists in the Palazzo dei Conservatori, but the children and parts of the wolf are restorations For the history of the group, see Petersen, *Lupa Capitolina*, *Klio*, 8 440–456, 9 29–47

The suckling of the children by the wolf was represented frequently on mirrors, coins, gems, reliefs and by statues in the round, and even beside a sepulchral inscription (*C I L*, VI 22811) A wolf giving suck to a single infant was carved beside a similar inscription (*C I L* , VI 24008)

[17] Ovid, *Fasti*, 3 46, Plut , *Rom* , 4 and 7, Plut , *Mor* , 320 D, Aur Vict , *Orig Gent Rom* , 20

[18] The strange experience of Romulus and Remus caused the people near by to refrain from exposing any of their offspring, they carefully fostered all their new births —Plut , *Mor* , 320 E

[19] Plut , *Rom* , 2

[20] *Mor* , 320 F (*Parallels*, 36)

Another wolf-nursed child was Miletus, the son of Acacallis and Apollo, who was exposed by his mother through fear of her father Minos. By the wish of Apollo wolves guarded the child and gave it suck.[21]

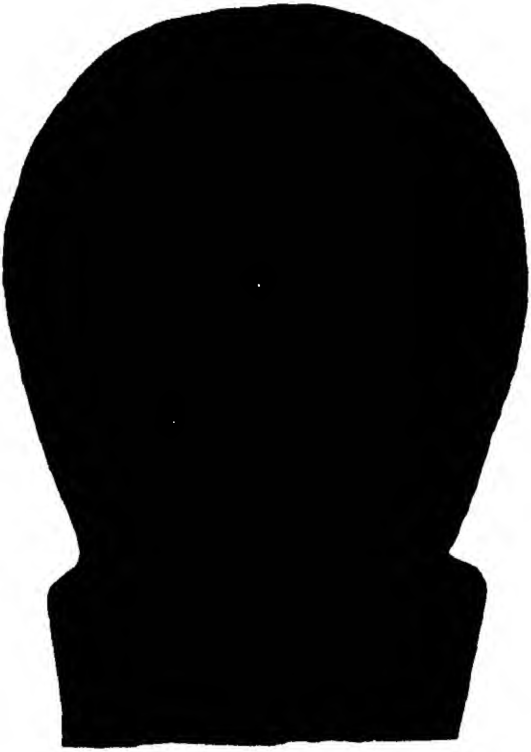


FIG. 2. An Etruscan Grave-stone showing a Child Suckled by an Animal, obviously a Lion.

On an Etruscan grave-stone in the Museo Civico at Bologna a child is represented as suckled by an animal.[22] (See Text Fig. 2.)

[21] Ant. Lib., 30.

[22] *Monumenti Antichi*, 20. 531. Other Etruscan parallels have been collected by P. Ducati, *Una Stele Etrusca del Museo Civico Bolognese*, in *Atti e Memorie d. R. Deputazione di Storia Patria per la Romagna*, 25 (1907). I have not, however, managed to get access to this book.

In spite of the fact that there is but one child, some Italian archaeologists, evidently laboring under the influence of the legend of Romulus and Remus, identify the animal as a wolf, but it is clearly a lion [23]

Cyrus, the son of Mandane and Cambyses, was exposed by order of his grandfather, King Astyages, who had been alarmed by a dream He was given to a shepherd and exposed, but the shepherd, at the entreaties of his wife, returned to the child and found it being suckled by a dog and defended from wild beasts and birds This is the story as told by Justinus, [24] but we shall find that a different version was given by Herodotus

Paris was exposed on Mount Ida because the night before his birth Hecuba had dreamed that she had brought forth a fire-brand After being nursed for five days by a bear, he was found by shepherds who reared him [25]

Atalanta, exposed by a father who wanted a male child, was suckled often by a bear She was found and reared by hunters [26]

Aesculapius, the son of Coronis and Apollo, was exposed by his mother among the mountains in the land of the Epidaurians He was suckled by a goat and guarded by a dog until rescued by shepherds [27]

Phylacides and Philander, children of a nymph Acacallis and Apollo, were suckled by a goat A bronze statue of the goat suckling the infants was sent to Delphi by the city of Elyrus in Crete [28]

Aegisthus, the son of Pelopia by her own father was exposed by his mother After being rescued by shepherds, he was given to a goat to be suckled [29]

[23] Paws, breadth of face, mane and heavy-set body all show that it is a lion

[24] 1 4 (cf 44 4 12), Ael, *Var Hist*, 12 42

[25] Schol on Homer, *Il*, 3 325, Apollod, *Bibl*, 3 12 5, Hyg, *Fab*, 91, *Scriptores Rerum Mythicarum Latini*, ed G H Bode, vol 1, p 139 (*Second Vatican Mythographer*, 197), Tzetzes, *Schol on Lycophron*, 138, Ael, *Var Hist*, 12 42 See also Pease on Cicero, *De Div*, 1 42

[26] Apollod, *Bibl*, 3 9 2 The story is told with elaborate detail by Aelian, *Var Hist*, 13 1

[27] Paus, 2 26 3–5

[28] Paus, 10 16 5

[29] Hyg, *Fab*, 87, 88, 252, Ael, *Var Hist*, 12 42

Attis, the son of Nana, who conceived by putting into her bosom the fruit of the pomegranate, was exposed by order of his grandfather, the king or the river Sangarius According to one account, he was tended by a he-goat,[30] according to another, he was found by Phorbas, presumably a goat-herd, and brought up on he-goat's milk[31]

Daphnis and Chloe, whose love affairs are described by Longus,[32] were exposed in their infancy and nursed by animals, the former by a goat,[33] the latter by a ewe[34]

Hippothous, the son of Alope and Neptune, after being exposed at his mother's orders, was suckled by a mare until found by a shepherd He was given to a fellow-shepherd without, however, the tokens of his birth In a dispute the shepherds appealed to King Cercyon, who found out that the child was his daughter's He gave orders for the child to be killed, but it was exposed a second time, again suckled by the mare and found by the shepherds, who then reared it[35]

Camilla was the daughter of Metabus, a king of the Volscian town of Privernum When he was expelled, he took his child with him and had her suckled by a mare[36]

Pelias and Neleus, children of Poseidon and Tyro, were exposed by their mother, but were suckled by animals, the former by a mare, the latter by a bitch Both were found and reared by shepherds[37]

Harpalyce, daughter of Harpalycus, king of the Amymnori, lost her mother in infancy Her father had mares and cows suckle her[38]

Aeolus and Boeotus, sons of Melanippe and Poseidon, were

[30] Paus, 7 17 11 [31] Arnob, *Adv Nat*, 5 6, 5 13

[32] *Daphnis and Chloe*

[33] *Op cit*, 1 2, 4 36 *et passim*

[34] *Op cit*, 1 5, 4 36 *et passim*

[35] Hyg, *Fab*, 187, 252, Ael, *Var Hist*, 12 42

[36] Hyg, *Fab*, 252, Serv *ad Verg*, *Aen* 1 317

[37] Eustath on *Odyss*, 11 253, p 1681, Ael, *Var Hist*, 12 42 See also Eustath, p 1681, who says that Pelias was struck by a mare that passed by, so that his face became black, and hence the shepherd who found him called him Pelias (from πελιός)

[38] Hyg, *Fab*, 193, 252

exposed by their grandfather's orders, but were suckled by a cow They were found by herdsmen and reared by them [39]

Antilochus, the son of Nestor, was suckled by a dog when exposed on Mount Ida [40]

Cydon, the eponymous hero of Cydonia in Crete, was the son of Tegeates and Maera, [41] or else of Acacallis by Hermes [42] or Apollo [43] There is no literary record of his exposure, but coins of the city show him being suckled by an animal that is obviously a dog [44] (See Plate II, Fig 3)

Damascus, son of the Arcadian nymph Halimedes and Hermes, went to Syria, according to Stephanus of Byzantium, [45] and founded the city of the same name [46] We have no literary evidence that he was exposed as a child, but two coins of Damascus minted while the city was under Roman rule show on the reverse a child sitting under a doe and grasping its teats in order to facilitate suckling [47] (See Plate II, Fig 4) The child is evidently the (Greek) eponymous founder of the town The suggestion has been made that there may be a pun on the name of the city and *dam(m)a*, [48] 'doe' [49]

Telephus, son of Auge and Hercules, who had been exposed on Mount Parthenius by order of his maternal grandfather,

[39] Hyg, *Fab*, 186 252 See also Nauck, *Tragicorum Graecorum Fragmenta* (1889), pp 509-510

[40] Hyg, *Fab*, 252

[41] Paus, 8 53 3-4

[42] Paus, 8 53 4

[43] Stephanus of Byzantium, s v Κυδωνία

[44] *A Catalogue of the Greek Coins in the British Museum, Crete*, Pl VII, Nos 4-7 Roscher, s v *Apollon*, p 439, says the animal is a wolf It has a long, slender, sinewy body, an ideal build for a hound I am glad to find my own view confirmed by Keller, *Die antike Tierwelt*, I 118

[45] S v Δαμασκός Stephanus gives other theories of the origin of the name

[46] It is rather amusing to find a nation creating an eponymous hero for foreign lands There are other instances of this process

[47] *A Catalogue of Greek Coins in the British Museum, Galatia*, p 286, No 24, p 288, No 29 (Plate XXXV, Fig 5)

[48] The difference in the quantity of the *a* in the initial syllables would not necessarily militate against this idea.

[49] *Neue Jahrbücher f d kl Alt*, 7 (1901), 395

was suckled by a doe He was found and reared by shepherds [50] (See Plate II, Fig 5)

Meliteus, the child of the nymph Othreis and Zeus, was exposed in a woods by his mother because of her fear of Hera At the wish of Zeus he was nurtured and reared by bees until found by a shepherd [51]

Hieron II, king of Syracuse, was the son of Hierocles, a Syracusan of illustrious birth, by a servant In consequence of his ignoble birth he was exposed, but was fed by bees for many days [52]

There are conflicting traditions about Pindar, but according to one of them bees fed him with honey when he happened to be left alone [53]

Cycnus, son of Scamandrodice [54] and Poseidon, was exposed on a seashore by his mother He was rescued by fishermen whose attention was attracted to him by seeing a swan hovering above him [55]

The popular Babylonian hero Gilgamesh (called Gilgamus by the Greeks) was the natural son of a king's daughter The king was told by Chaldaeans that the issue of his daughter would take his kingdom from him In fear he had the girl

[50] Apollod, *Bibl*, 2 7 4, 3 9 1, Diod, 4 33 7-12, Hyg, *Fab*, 99, Strabo, 13 1 69 p 615 Dio Chrysostom, *Orat*, 64 (p 213, ed Dindorf), Ael, *Var Hist*, 12 42, Paus, 8 4 9, 8 47 4, 8 54 6, 9 31 2, 10 28 8, Tzetzes on Lycophron, 206

Garrucci, *Le Monete dell' Italia Antica*, Pl LXXXVI, Nos 29-30 figures Oscan coins showing Heracles on the obverse and Telephus suckled by the doe on the reverse See also the text on page 88 The reverse has been described as representing an Oscan hero suckled by a dog Since the animal in question has a short tail and hoofs instead of paws, I have no doubt that it is meant to be a doe

[51] Ant Lib, 13

[52] Justinus, 23 4 6-9

[53] Ael, *Var Hist*, 12 45, Dio Chrysostom, *Orat*, 64 (p 213, ed Dindorf)

[54] According to some authorities his mother was Calyce or Harpale

[55] Lycophron, *Alexandra*, 237, says that he was 'gull-nursed,' but Tzetzes in his note on Lycophron, 236-239 says that he was 'swan-nursed' Tzetzes gives the most detailed form of the tradition in his note on line 232 From Porphyrius, *De Abstinentia*, 3 17, we get confirmation of the version which says the bird was a swan

guarded, but she gave birth to the child secretly The guards threw it from the acropolis, but before it could be crushed upon the ground an eagle, seeing its hasty descent, swooped down under it, caught it on its back and carried it to a garden, where it was rescued and reared by the caretaker [56]

The Persian Achaemenes was said to have been a nursling of an eagle [57]

Ptolemy (later called Soter), the son of Lagos and Arsinoe, was exposed on a bronze shield by his father An eagle came to it and with its wings protected it from the direct rays of the sun and sheltered it from rain It also kept other birds away In lieu of milk it furnished its own blood as sustenance [58]

Into the Euphrates River there fell an egg of great size, which fish rolled to the bank Doves sat on it and hatched out a goddess, who was afterwards called 'Syrian Venus' From that time Syrians refrained from eating fish and regarded doves as sacred [59]

Semiramis, the daughter of a Syrian goddess, Derceto, by a worshipper, was exposed in barren rocky regions Doves which were nesting near by providentially reared the child Some kept her warm by spreading their wings over her, others brought milk from neighboring camping-grounds of royal herdsmen A year later, when the child needed more substantial food, they began to provide cheese from the same source Moved to investigate the cause of their losses, the herdsmen found the infant One of them, who was childless, reared the baby, calling it Semiramis from the Syrian word for 'dove' In the meantime Derceto had thrown herself into a marsh and had been transformed into a fish Because of this a taboo was placed on fish by the Syrians and they were honored as gods [60]

Iamus, the son of Evadne and Apollo, was fed with honey

[56] Ael, *De Nat Anim*, 12 21

[57] *Loc cit*

[58] Suidas, s v Λάγος

[59] Hyg, *Fab*, 197 For references to interesting passages on the sanctity of doves in Syria, see D W Thompson, *A Glossary of Greek Birds*, p 144

[60] Diod, 2 4 Hesychius, too, s v Σεμίραμις, says that the word means 'dove'

by two serpents when his mother deserted him [61] He became the founder of a family of seers, the Iamidae

Closely allied to these wonder-tales are stories in which older persons are said to have been saved by animals Thoas, an Arcadian boy, had a snake of which he was very fond, but the father, fearing its huge size and the fierceness of serpents, took it and the boy away to the woods on the same couch while they were sleeping The boy stayed in the woods with the snake In young manhood when he was beset by robbers, the snake heard his voice and came to his assistance [62]

A maiden, presumably Myrmex, who was changed into an ant by Minerva, is represented on gems as being guarded by ants in her sleep, or as having an eagle hovering over her Sometimes a snake is coiled about a tree beside her [63] (See Plate II, Figs 6, 7, 8)

A remarkable case of a friendship between man and beast is quoted by Aulus Gellius [64] During an exhibition in the Colosseum a slave was introduced to fight a fierce and powerful lion As soon as the beast saw the man, it approached in a friendly manner and began to fawn upon him and caress him When asked for an explanation Androclus said that while his master was holding a proconsulship in Africa he had run away and sought refuge in a cave Not much later a lion entered and came to him gently holding up one foot Androclus found in it a thorn which he extracted and then pressed out the clotted blood This was the beginning of a companionship that lasted three years Finally, becoming tired of the meat of wild animals, Androclus left the cave and was captured by soldiers His master took him to Rome to be given to the beasts in the arena

[61] Pind , *Olymp* , 6 45–47

[62] Pliny, *Nat Hist* , 8 61, Ael , *De Nat Anim* , 6 63 Compare the fable in which it is said that a wolf spared Gelon, thereby indicating that he would rise to royal power — Ael , *De Nat Anim* , 13 1, Justinus, 23 4 6–9 Compare the rescue of Arion by a dolphin — Gellius, *Noct Att* , 16 9

[63] See Fürtwangler, *Die antiken Gemmen*, Pl XXV, Nos 44–45, Pl XXXX, Nos 1, 49–52, 54–58 See Rossbach, *Neue Jahrbücher f d kl Alt* , 7 (1901) 398–399, for the identification of the sleeping maiden

[64] 5 14

By great good fortune the lion turned loose upon him was the one he had treated in the cave.[65] Perhaps no friendship was ever renewed in more spectacular or dramatic fashion.[66]

Such stories as I have been relating must have been extremely common in antiquity. It is safe to say that many of them were lost in the destruction that overtook classical manuscripts. There are no longer extant literary traditions about a number of heroes represented on grave-stones, coins and gems as suckled by animals.

In my collection from Greek and Latin sources there are almost forty instances of children nurtured or protected by animals and two of gods. In five of these cases twins are exposed. All the children are male except Cybele, Camilla, Semiramis, Atalanta, Harpalyce and Chloe.[67] In nine accounts the gods Zeus, Poseidon, Apollo, Mars and Hermes are the reputed fathers.[68] Among wild animals serving as attendants

[65] Aelian, *De Nat. Anim.* 8. 22, tells a fabulous tale of a stork's bringing a magic pebble to a woman who had treated its broken leg the year before.

[66] There are several points of similarity between the experience of Androclus and that of the lion-trainer of the following clipping, which I culled from a Philadelphia newspaper some twelve years ago without, unfortunately, making note of the date.

"Of all the young women in the country, Miss Ruby Roberts, of Chicago, probably has chosen the most unique method of spending her two-week vacation, for she is traveling as the guest of Leo, the big Abyssinian lion, with Ringling Brothers' circus.

"One evening recently in Indianapolis crowds in the menagerie of the show were startled by the roaring of one of the lions, and a few moments later were amazed to see a woman in street dress enter the cage. Instantly the great beast was at her feet, purring like a kitten, while she patted him on the head and fondled him as though he were a St. Bernard.

"The lion and the woman were old friends. Ten years ago, under the name of Mlle. Doramne, Miss Roberts was a trainer for Ringling Brothers. The meeting with her old pet had been entirely by chance, and the recognition came from the lion. The woman was passing the cage when Leo opened his sleepy eyes and recognized his old mistress. He leaped to his feet, and, thrusting his paws through the bars, roared the greeting that attracted her attention."

[67] In parallels from other literatures I have noted no instance of the nursing of a girl.

[68] This is probably only another way of saying that the children were born out of wedlock. We are told by Livy, 1. 4. 2, that Rhea Silvia claimed that Mars was the father of her children, either because she actually thought

are wolves, bears, panthers, lions and deer, among domestic animals, goats, horses, cows, sheep, dogs and pigs, among birds, doves, eagles and woodpeckers, [69] among insects, bees Fish and serpents are also listed It will thus be seen that the animal nurses are not restricted to mammals Although the rescuers are not always mentioned, it is stated in thirteen cases that shepherds found the infants Of the children exposed several are eponymous heroes, namely, Romulus, [70] Aeolus, Boeotus, [71] Miletus, [72] Iamus, [73] Damascus [74] and Cydon [75] Parrhasia already had an eponymous hero in a son of Lycaon, it is not impossible, however, that the story of Lycastus and Parrhasius is another attempt to create such a hero

ANCIENT AND MODERN THEORIES OF THE ORIGIN OF THE STORIES

The ancients themselves were struck by the parallelism of these stories There is not to my knowledge any other kind of folk-tale which they tried so hard to explain

In the days when animals were supposed to be endowed with speech and understanding and were in fact put more or less on a parity with man, it was easy for such tales to gain credence and currency In the mind of primitive man there was about them an atmosphere, not of possibility and probability, but of reality The tales were not, however, wholly fanciful in every instance Cases of wolf-reared children in India have been too

so, or because it was an extenuation of her shortcoming to have a god responsible Servius, *ad Verg*, *Aen*, 1 273, is very explicit on this general subject

[69] There is one reference to birds in general, Plut, *Rom*, 2

[70] Verg, *Aen*, 1 276-277 The eponymous character of this name appears more clearly in the form Romus, as given, for example, by Serv, *ad Verg*, *Aen*, 1 273

[71] Diod, 4 67 6, Hyg, *Fab*, 186, end The same references serve for Aeolus

[72] Ant Lib, 30

[73] Iamus became the founder of the Iamidae

[74] Stephanus of Byzantium, s v Δαμασκός

[75] Stephanus of Byzantium, s v Κυδωνία, Paus, 8 53 4

well authenticated to permit of doubt. A European traveller who investigated the subject with great care writes as follows:

My attention was, in the first place, drawn to this subject by the following extract from the Report of the Sekrandra Orphanage, which towards the end of the year 1872 went the round of the Indian papers:

"A boy of about ten *was burned out of a den in the company of wolves*. How long he had been with them it is impossible to say, but it must have been for rather a long period, from the facility he has for going on all fours and his liking for raw meat. As yet he is very much like a wild animal, his very whine reminds one of a young dog or some such creature. Some years ago we had a similar child; he has picked up wonderfully, and though he has not learned to speak, can fully express his joys and grief. We trust the new 'unfortunate' may soon improve too." [76]

I immediately wrote to the Superintendent of the Sekandra Orphanage for confirmation of the story, and for any further information on the subject. To this application I received the following reply from the Rev. Mr. Erhardt: "We have had two such boys here, but I fancy you refer to the one who was brought here on March 6th, 1872. He was found by Hindus who had gone hunting wolves in the neighbourhood of Mynepuri. Had been burnt out of the den, and was brought here with the scars and wounds still on him. In his habits he was a perfect wild animal in every point of view. He drank like a dog, and liked a bone and raw meat better than anything else. He would never remain with the other boys, but hid away in any dark corner. Clothes he never would wear, but tore them up into fine shreds. He was only a few months among us, as he got fever and gave up eating. We kept him for a long time by artificial means, but eventually he died.

"The other boy found among wolves is about thirteen or fourteen years old, and has been here about six. He has learnt to make sounds, speak he cannot, but he freely expresses his anger and joy. Work he will at times, a little, but he likes eating better. His civilisation has progressed so far that he likes raw meat less, though he still will pick up bones and sharpen his teeth on them.

"Neither of the above are new cases, however. At the Lucknow Madhouse there was an elderly fellow only four years ago, and may be alive now, who had been dug out of a wolves' den by a European doctor, when I forget, but it must be a good number of years ago.

"The facility with which they get along on four feet (hands and feet) is surprising. Before they eat or taste any food they smell it, and when they don't like the smell they throw it away."

After giving several other instances[77] the same writer says:[78]

Supposing the above stories to be true, the only suggestions which I can offer to account for the preservation of the children from the ordinary

[76] V. Ball, *Jungle Life in India, or the Journeys and Journals of an Indian Geologist*, pp. 457–459.

[77] See pages 455–466.

[78] Page 465.

fate, are that, firstly, it may be that while one of a pair of wolves has brought back a live child to the den, the other may have contributed a sheep or goat to the day's provision, and that this latter proving sufficient for immediate wants, the child has been permitted to lie in the den, and possibly to be suckled by the female, and has so come to be recognised as a member of the family Secondly, and, perhaps more probably, it may be that the wolf's cubs having been stolen, the children have been carried off to fill their places and have been fondled and suckled

There is one curious point common to all the stories, to which attention has not been previously drawn, it is that all the children appear to have been of the same sex — namely, boys There is no record, I believe, of a wolf-reared girl

There are still other examples [79] of wolf-nurture that are equally trustworthy [80]

Goats, too, have mothered children "It is marvellous," says one writer,[81] " how soon goats find out children and tempt them to suckle I have had the milk of my goats, when encamping for the night in African travels, drained dry by small black children, who had not the strength to do more than crawl about, but nevertheless came to some secret understanding with the goats and fed themselves"

The most reliable ancient account of animal-nursing is told by Procopius [82] in his account of the Gothic invasion of Italy When the army under Joannes entered Picenum, there was great commotion among the population Some of the women managed to escape by a hasty flight, others were captured One woman of Urbs Salvia left lying on the ground in swaddling clothes a child to which she had recently given birth When the babe began to cry a goat which had just born a kid came to it, giving it suck and protecting it from dogs and other animals Since the situation in Picenum was disturbed for some time, the child continued under the care of its foster-mother Finally the women who were of Roman descent returned to the town

[79] *Panjab Notes and Queries*, III (1885), Nos 552, 602, 603, 604, 659, 660, 661, *Rept Ind Eth Com*, 1866–1867, p 52

[80] For most of my modern illustrations of animal nurses I am indebted to references in the valuable note of Frazer on Pausanias, vol III, pp 234–235

[81] F Galton, *Transactions of the Ethnological Society of London, N S*, 3 (1865), 135–136.

[82] *De Bello Gothico*, 2 17

with their husbands and found the child. Its healthy condition was a source of great wonder to them since they saw no apparent means of sustenance. Some of the women endeavored to nurse the child, but it refused human milk. The goat was unwilling to resign its attentions, and stood near by bleating and seeming to take it hard that the women annoyed the child. Thereupon the women stepped aside and the goat guarded and nourished the child with great care. For this reason the people called the infant Aegisthus. Procopius thus concludes his story: "When I happened to be staying there, the people wishing to show a thing that taxed belief, took me to the child and annoyed it on purpose that it might cry, but the goat, which was only a stone's throw away, on hearing it, came running to it bleating loudly, and reaching it stood over it that no one might disturb it further. Such is the story of this Aegisthus."

I see no reason for doubting this account. There is one very reassuring piece of evidence that is lacking in all the others, namely, the addiction of the infant to goat's milk. Animal-nursed children retain their wild dietary habits. Another point in favor of the narrative is that the child was not destined to become a national hero. I see no object in the fabrication of such a story. Procopius is a matter-of-fact historian.

The accounts which tell of parents or shepherds having children suckled by animals are of course not improbable in and of themselves.[83] Doctors have done the same thing in modern times.

More of these tales are related of Zeus than of any person

[83] The ancients went a step beyond this. One writer says that the *boa*, a water-snake, was so called because it milked cows (Sol., 2. 33). Superstitious people in our own country still believe that black-snakes, garter-snakes and milk-snakes suck milk from cows. See F. D. Bergen, *Animal and Plant Lore*, pp. 86–87. "Hedgehogs fasten on the dugs of cows, and drain off the milk." — Brewer, *The Reader's Handbook*, p. 1057. I have, however, a newspaper picture showing a cow giving suck to a pig. The photographer was afraid that a verbal account of what she had seen would not be credited by her neighbors. Another newspaper picture shows a cat nursing two young squirrels after it had been deprived of its kittens. One of my newspaper clippings tells how a cat nursed a white rat that had been added to her brood of kittens. A recent moving-picture showed a dog giving suck to kittens.

There may be a reason for this A new cult or religion finds it almost impossible to make an appeal without the aid of the miraculous, or at least of the strange and the unusual We see this in Christianity itself and, to come nearer home, in Mormonism

The story that doves carried ambrosia to Zeus overtaxed the credulity of several of the ancients Athenaeus [84] makes fun of the belief He says that the bearers were the daughters of Atlas, metamorphosed into the constellation of the Pleiades, a name which he associated etymologically with 'doves' [85] According to a scholium on the Odyssey [86] Homer spoke mythically or metaphorically in saying that the doves which flew through the Symplegades carried ambrosia to Zeus

Diodorus regards the story of the rearing of Semiramis as palpably mythological [87] Strabo [88] is equally incredulous about Romulus and Remus The account of the feeding of Zeus by bees is not worthy of the serious consideration of Columella [89] Lactantius called it a 'poet's tale' Arnobius [90] was disgusted with traditions about the he-goat and Attis

Though there were in Rome 'fundamentalists' who accepted in its entirety the account of Romulus and Remus as it had been handed down, the 'liberalists' explained that the term *lupa*, 'wolf,' meant prostitute, and that the wolf that reared the foundlings was only a metaphorical one, Acca Larentia, the wife of the shepherd who rescued them [91]

One of the numerous ancient etymologies for the names 'Romulus' and 'Remus' derives them from *ruma* or *rumis*, old Latin words for 'breast' [92] Rumina was the goddess of suckling

[84] *Ll cc*, 79–80

[85] On the mythical astronomy of the Pleiades, see Thompson, *A Glossary of Greek Birds*, p 132

[86] 12 62

[87] 2 5 1

[88] 5 3 2

[89] 9 2 2

[90] *Adv Nat*, 5 13–14

[91] Livy, 1 10 4, Plut, *Rom*, 4 3, Serv *ad Verg*, *Aen*, 1 273, Aur Vict, *Orig Gent Rom*, 21

[92] Plut, *Rom*, 6 2 See also Varro, *Res Rust*, 2 11 5, Plin, *Nat Hist*, 15 77, Festus, s v *Ruminalis* (pp 332, 333, Lindsay), *Romulum* (p 326, Lindsay)

"It appears that the word Romulus suggested to a Roman ear the notion of 'suckling' We thus discover the association which converted the twin Lares of the Roman state into two suckling children "[93]

The fatherhood of illegitimate children is often attributed to divinities As soon as the god Mars is brought into the story the selection of animals to tend the babes is almost inevitable We are told by Plutarch[94] that the chief reason why the mother was believed when she ascribed their paternity to Mars was the fact that the wolf and the woodpecker were held in special veneration and honor by the Latins The tradition about the woodpecker is not mentioned so frequently, either because it is less dramatic, or perhaps, because it is a late accretion

Some scholars see Greek outlines in the Romulus-Remus story and find striking parallels between it and the fragments of Sophocles's *Tyro*, in which Neleus and Pelias figure[95] They believe that the differences are the modifications necessary to impart local color The literature about the twin founders of Rome is, however, too involved to permit further discussion here[96]

As was the case in Rome with Romulus, Greek or Persian rationalists endeavored to eliminate the improbable features of the legend of Cyrus by saying that the dog which raised the prince was the shepherd's wife, who was named Spako, 'Bitch'[97]

[93] Seeley, *Livy, Book I*, p 33

[94] Plut, *Rom*, 4 2 Cf Plut, *Mor*, 320 D, Serv *ad Verg*, *Aen*, 1 273

[95] See C Trieber, *Die Romulussage*, *Rhein Mus*, 43 569–582, pp 105–111 of the reference to Soltau in the next note and p 173 of the one to Roscher Petersen, *Klio*, 9 45–47, does, however, take a different view The last word on the subject has not been said

[96] See Roscher, *Ausführliches Lexikon der griechischen und römischen Mythologie*, s v *Romulus* Seeley, *Livy, Book I*, pp 31–34, De Sanctis, *Storia dei Romani*, I 206–217, Pais, *Storia Critica dei Romani*, I Part 1 289–295, F Liebrecht, *Zur Volkskunde*, pp 17–25 (*Romulus und die Welfen*), W Soltau, *Die Entstehung der Romuluslegende*, *Archiv fur Religionswissenschaft*, 12 101–126 Twenty-four versions of the founding of Rome have been collected by G C Lewis, *An Inquiry into the Credibility of the Early Roman History* (1885), I 395–401

[97] On the Cyrus legend see A Bauer, *Die Kyros-Sage und Verwandtes*, *Sitzungsberichte der philosophisch-historischen Classe der kaiserlichen Akademie der Wissenschaften*, 100 495–578

Herodotus[98] recounts the story only in its rationalized form Justinus,[99] after telling how Cyrus was nurtured by a dog, says that the wife of the shepherdess was later called Spaco, the Persian word for bitch He does not seem to understand why A distant echo of the ancient controversy between the 'literalists' and their opponents is seen in Dio Chrysostom's hedging statement that Fortune sent to Cyrus either a dog or a woman[100]

The tradition that the nymphs Adrasteia and Ida, to whom Rhea gave the child, were the daughters of Melisseus (cf μελισσεύς, 'bee-keeper') is very probably an attempt to rationalize the account[101] The effort is a little more patent when the daughters' names are given as Melissa and Amalthea[102] Lactantius does say in so many words that from the name Melissa originated the poet's tale that bees flew to the mouth of the child and fed him with honey[103] Several sources tell us that Amalthea was the name not of the goat, but of the maiden or nymph who owned the goat and nursed Zeus[104] The naming of one of the nurses Aega (cf αἴξ, 'goat') is another evident attempt to explain away the services of the goat as milkman[105] Only by way of jest, according to Hyginus,[106] is the goat said to have nursed Zeus

The ancient fondness for aetiology will doubtless account for some of these wonder-tales Frazer[107] would put the legend of Aesculapius in this category

"From inscriptions we see that sacred dogs were kept in the sanctuary of Aesculapius, and that they were supposed to heal the sick by licking them Festus (*s v In insula*) says that "dogs are kept in the temple of Aesculapius because he was

[98] 1 122 [99] 1 4 14

[100] *Orat*, 64 (p 213, ed Dindorf)

[101] See Frazer, Apollodorus, 1 1 6, and note *ad loc*

[102] Lactantius, *Div Inst*, 1 22

[103] *Loc cit.* Cf Colum, *De Re Rust*, 9 2

[104] Aratus ap Strab, 8 7 5, p 387, Hyg, *Astron*, 2 13, *Second Vatican Mythographer*, 16 (in G H Bode, *Scriptores Rerum Mythicarum Latini*) Eratosthenes, *Cataster*, 13, Ovid, *Fasti*, 5 115–116

[105] Hyg, *Astron*, 2 13

[106] *Astron*, 2 13

[107] *Pausanias*, vol III, p 250

suckled by a bitch" Lactantius (*Divin Inst*, 1 10) also says that the youthful Aesculapius was nourished on dog's milk Hence the story told by Pausanias (ii 26 4) that the infant Aesculapius was suckled by a goat and guarded by a dog, appears to be an attempt to combine two separate legends, which explained the sacredness of the goat and dog in the worship of Aesculapius by saying that the god had been suckled by a goat or (according to the other version) by a dog"

To reward the goat for its services Zeus placed it among the constellations, so says tradition [108] May the process have worked the other way? May not the story of the nurture of Zeus by a goat have been created to account for the presence of the goat among the constellations?

There can not be much doubt that the story of the Syrian goddess is told to explain the peculiar esteem of the Syrians for fish and doves The fable of Semiramis may be regarded as a variant with the same end in view, as far as it concerns fish Diodorus [109] says that the taboo on fish dates from her mother's transformation into a fish His failure to make mention of the Syrian regard for doves and his derivation of the name Semiramis from the word for 'dove' incline me to believe that the major portion of the tale explains how the heroine got her beautiful and striking name

The makeshift nature of the association of fish and doves with Semiramis and Derceto is shown by the fact that there are still other ways of accounting for the taboos on these creatures One author [110] says it is due to the fish-like form of Derceto and to Semiramis's final transformation into a dove, another, [111] after making Rhea a meteorological deity, says that Hera seems to be the same as the goddess Atargatis whom the Syrians honor by refraining from eating fish and doves, which are symbolic of air and water The Syrian taboo on fish and doves is probably just as unexplainable as that of the Hebrews on pork

[108] Serv *in Verg*, *Aen*, 9 665, *in Georg*, 1 205, Ovid, *Fasti*, 5. 117-128

[109] Diod, 2 4 2

[110] Lucian (?), *De Syria Dea*, 17

[111] Cornutus, *Theologiae Graecae Compendium*, c 6

Stories other than that of Semiramis may be due to the suggestion of a name Among the ancients proper names (as well as ordinary words) were regarded as significant and there are many passages dwelling on the suitability or unsuitability of a name to its possessor One Greek who was not satisfied with the Homeric etymology of the name Odysseus [112] saw in it a more or less superficial resemblance to the noun **ὁδός**, 'road,' and the infinitive *ὗσαι*, 'to rain' [113] Hence the story was created out of the whole cloth to the effect that the mother of Odysseus was overcome with the pangs of childbirth while on a journey and that the child was named with reference to the rain in the road [114]

The ancients said that Aegisthus, [115] Cycnus, [116] Hippothous,[117] Melitus,[118] Telephus [119] and Attis [120] were named from the animals that reared them If there was any association at all between these individuals and animals, it is likely that it was due to the names of the persons Several dozen Greek and Latin proper names are derived from words designating animals and there are many puns that were suggested by them Lactantius did in fact ascribe to the suggestion that lay in the names Amalthea and Melissa the story that Zeus was fed by a goat and by bees I take at its face value, however, the story of the naming of the Aegisthus in the account of Procopius

A satisfactory explanation of the association of the bee with Zeus has been made by A B Cook [121] "Left to itself it chooses as its abode some crevice in cliff or stone Wilkinson, writing of

[112] *Odyss.*, 19 407–409

[113] Silenus ap Eustath on *Odyss*, 19 407

[114] Παρὰ τὸ ἐν τῇ ὁδῷ ὗσαι

[115] Hyg, *Fab*, 87

[116] Porphyrius, *De Abs*, 3 17, Tzetzes, ad Lycophron, 232

[117] Hyg, *Fab*, 187

[118] Ant Lib, 13

[119] In the account of Apollodorus, 2 7 4 the name seems to be derived from *thele*, 'dug,' and *elaphos*, 'deer' See Frazer, *ad loc*

[120] Arnob, *Adv Nat*, 5 6, says that Attis was so named either from the Phrygian words for goats, *attagi*, or because handsome fellows in general had such a name

[121] P 17 of *The Bee in Greek Mythology*, *Journal of Hellenic Studies*, 15. 1–24.

Egypt, says —[122] 'The wild bees live mostly under stones or in clefts of the rock, as in many other countries, and the expression of Moses and of the Psalmist, *honey out of the rock*,[123] shows that in Palestine their habits were the same' What applied to Egypt and the Levant held good for Greece " [124]

The legend domiciled bees in the Cretan cave As Cook explains,[125] nothing could be more natural than that the bees haunting the traditional birthplace of Zeus should be regarded as his attendants

Another tack must be used to account for the connection of the bee with Pindar The figure of honeyed words or speech is common in Greek, being well established in Homer and Hesiod, the earliest Greek writers extant It was doubtless this metaphor that gave rise to the idea that bees alighted upon or fed infants that were destined to become sweet singers or eloquent speakers [126]

There is at present a tendency to find evidences of totemism in classical folk-lore [127] I have seen the suggestion made in print three times that the stories under discussion are due to, or survivals of, totemism [128] In conversation with me an anthropologist of wide experience attributed them to the same source Totemism would explain the Syrian taboo on fish and doves Again, the common North American Indian story in which the suckled child takes the name of the animal that nursed him and becomes the progenitor of a tribe named from the animal,[129] is certainly not radically different from the classical type in which an eponymous hero is suckled

[122] *The Ancient Egyptians*, II 415

[123] *Deut*, xxxii 13, *Psa*, lxxxi 16

[124] See Homer, *Iliad*, 2 87 ff, 12 167 ff

[125] *Op cit*, p 5

[126] See A S Pease on Cicero, *De Divinatione*, 1 78, Margaret W Morley, *The Honey-Makers*, pp 286–287, Robert-Tornow, *De Apium Mellisque apud Veteres Significatione*, pp 89–103, 114–118

[127] E g, Jane Harrison, *Themis*, pp 118–157

[128] De Sanctis, *Storia dei Romani*, I 213–214, Pais, *Storia Critica di Roma*, I Part I, 293, J A Macculloch, *The Childhood of Fiction*, p 277, n 2 Roscher, *Lexikon der griechischen und römischen Mythologie*, s v Romulus, p 176, takes no stock in this theory

[129] For an illustration see S T Rand, *Legends of the Micmacs*, pp 259–262

A close European analogue to the American tales, later in date than the classical versions but representing an earlier type, is that of the ancestor of the Turks "Like Romulus, the founder of that martial people was suckled by a she-wolf, who afterwards made him the father of a numerous progeny, and the representation of that animal in the banners of the Turks preserved the memory, or rather suggested the idea, of a fable which was invented, without any mutual intercourse, by the shepherds of Latium and those of Scythia" [130]

While totemism offers a tempting solution of the 'type' story, so to speak, it seems best to accept this explanation with reservation, at least until classical scholars with training in anthropology cease to question the evidence for the existence of totemism among the Greeks and Romans

THE THEORY OF WONDER-CHILDREN

I think there can be little doubt as to the psychological reason for the creation of most of these stories They illustrate the tendency, which still exists, for incidents and anecdotes to cluster about the names and careers of distinguished men They are 'human interest' stories which do not fail to manifest the reporter's fondness for exaggeration The ancients wished to show that evidences of divine favor and omens of future greatness attended the hero or god even in youth

Suggestions of divine intervention and protection are in fact made by the ancients in narrating the youthful vicissitudes of Romulus and Remus,[131] Lycastus and Parrhasius,[132] Cyrus,[133] Cybele,[134] Semiramis,[135] Teléphus,[136] Daphnis and Chloe,[137] Hippothous [138] and Habis [139] The feeding of Hieron II by bees was interpreted by soothsayers as portending sovereignty for the

[130] Gibbon, *The Decline and Fall of the Roman Empire*, chap 42
[131] Livy, 1 4 4, Dionys, 1 79
[132] Plut, *Mor*, 314 E (*Parallels*, 36)
[133] Herod, 1 122
[134] Diod, 3 58 1
[135] Diod, 2 4 4
[136] Apollod, 2 7 4
[137] Longus, *Daphnis and Chloe*, 3 32, 4 36.
[138] Hyg, *Fab*, 187
[139] Just, 44. 4

infant[140] Pliny[141] thinks it better to attribute the suckling of infants by animals not to the nature of animals, but to the grandeur of the destinies to be fulfilled The mothering beast and the foster-father, frequently in the guise of a shepherd, appear with the timeliness of a *deus ex machina* in a divine tragedy

One ancient writer says that a person fortunate enough to have had an animal-nurse boasted not so much of his pedigree as of his having been nursed by an animal[142] In concluding his recital of the youthful perils of Romulus and Remus Plutarch says[143] "But we should not be incredulous when we see what a poet fortune sometimes is, and when we reflect that the Roman state would not have attained to its present power, had it not been of a divine origin, and one which was attended by great marvels"

These wonder-tales are told in general of national heroes and distinguished persons[144] They were regarded as proofs of the destinies that controlled the ends of heroes and heroines It is obvious, however, that they were created after the attainment of greatness or prominence Their adventitious character is shown at times by the existence of other conflicting stories which seem to be older or more natural[145]

There were, however, other ways of indicating wonder-

[140] Just, 23 4 6–9

[141] *Nat Hist*, 8 61 In the Wolfdietrich story the wolf's taking the baby prince to its lair was a manifest sign that God intended to aid the babe in its future life See Liebrecht, *Zur Volkskunde*, p 462

[142] Porphyrius, *De Abstinentia*, 3 17

[143] *Rom*, 8 7 Perrin's translation I should suggest 'craftsman' instead of 'poet' in the translation

[144] The story of Daphnis and Chloe I regard as a literary use of a folk-tale In his introduction the author tells us that while hunting in the grove of the Nymphs in Lesbos he saw a picture in which there were cattle suckling infants This and some other things that he saw inspired him to write the romance The first story in Kipling's *Jungle Book, Mowgli's Brothers*, which pictures a child among wolves, is another instance of the same sort of thing

[145] To disregard the many conflicting accounts of the founding of Rome, contrast the stories of Aeolus and Boeotus as told by Hyginus, *Fabulae*, 186, and Diodorus, 4 67 For the fable of Attis compare Arnobius, *Adv Nat*, 5 6 and 5 13 with Pausanias, 7 17 11

children There was a prevalent notion that when a child smiled or laughed at birth the future held something unusual in store for him[146] If an insect fed an infant that was not exposed the event was portentous A grain of wheat put in the mouth of the youthful Midas by an ant was a sign that he would be a rich man[147] If a bee alighted on the cradle of a sleeping infant and placed honey in its lips, the event was an omen of eternal felicity[148] "Those who were possessed of supernatural shrewdness, in particular singers and sages, are said to have been fed by bees, commonly during infancy"[149] Throughout the entire day on which Alexander the Great was born eagles remained perched on his father's house, an omen that signified double sway over Europe and Asia[150] When the Indian Sandrocottus, exhausted by his efforts to escape his pursuers, lay down to sleep, a lion approached him and wiped off his streaming perspiration with his tongue This omen aroused him to aspire to the kingdom[151]

Whatever may have been the origin of the 'type' story of animal-nursed children, when these tales became common in historical times, they formed simply one, though an important, entry in the catalogue of things that signified wonder-children

UNIVERSITY OF MICHIGAN

[146] See D R Stuart, *On Vergil, Eclogue IV 60–63*, *Classical Philology*, 16 209–230 See also the chapter on *Le Rire Rituel* in S Reinach, *Cultes, Mythes et Religions*, Vol IV, pp 109–129

[147] Cic, *De Div*, 1 78, Val Max, 1 6 *Ext* 2, Ael, *Var Hist*, 12 45

[148] Hae (apes) solidae et aeternae felicitatis indices exstiterunt, dormientis in cunis parvuli labellis mel inserendo —Val Max., 1 6 *Ext* 3

[149] Cook, *Journal of Hellenic Studies*, 15 7 For references see p 9 and also A S Pease on Cicero, *De Divinatione*, 1 78

[150] Just, 12 16 5

[151] Just, 15 4 13–20

EXPLANATION OF PLATE II

FIG 1 Clay impression of a seal found with the archives of the palace of Knossos, showing infant and horned sheep (× 3) Reproduced from *The Journal of Hellenic Studies*, XXI 129

FIG 2 The reverse of a Roman denarius, showing the wolf suckling Romulus and Remus (× 2) The object on the tree just above the wolf's back is a bird, evidently a woodpecker The figure behind the wolf is the shepherd Reproduced from *A Catalogue of the Roman Coins in the British Museum*, Vol III, Plate XXVI, Fig 6

FIG 3 A coin of Cydonia, showing the eponymous hero Cydon suckled by a dog Reproduced from *A Catalogue of the Greek Coins in the British Museum, Crete*, Plate VII, Fig 4

FIG 4 A coin of Damascus, showing a child, an eponymous hero (?), suckled by a doe Reproduced from *A Catalogue of the Greek Coins in the British Museum, Galatia*, Plate XXXV, Fig 5

FIG 5 A small section of a wall painting from Herculaneum, showing Telephus suckled by a hind Reproduced from *Guide du Musée National de Naples*, Plate 6

FIGS 6, 7, 8 Gems showing a maiden attended during her sleep by a serpent, by a bee and an eagle, and by an ant and an eagle Reproduced from Furtwangler, *Die antiken Gemmen*, Vol I, Plate XXX, Figs 56, 52 and 58, respectively (The figures are enlarged × 1½, 1½, 2½, respectively)

PLATE II

1

3

8

7

Antiquities showing Children Nursed by Animals (1–5) and a Maiden (Myrmex?) Guarded by Them (6–8)

EARLY MUSICAL SCALES IN THE LIGHT OF THE TWENTIETH CENTURY

CHARLES K WEAD *

YOUR attention is invited to a brief examination of some general aspects of the study of the beginnings of music and to some conclusions based on recent monographs The subjects of rhythm and percussion instruments must be excluded and the discussion limited to *early musical scales in the light of the twentieth century*

The early history of music both among the ancients and among primitive people now living is very imperfectly known, the successful study of it requires various kinds of knowledge rarely if ever possessed by one man — knowledge of foreign tongues, of psychology, of physics, and a little but not too much knowledge of European music

But what does one mean by "scale"? Disregarding medieval usages we today may mean by it (*a*) the series of sounds (or the notation of them) used in any musical performance arranged in order of pitch, (*b*) the series of sounds produced upon a particular instrument, or (*c*) most definitely, an independently reproducible series of sounds arranged in order of pitch, recognized as a standard, and fitted for musical purposes

This last definition covers only comparatively modern music and applies especially and predominantly to the equally tempered chromatic scale and to the diatonic scale, just or tempered, but it also covers Debussy's whole-tone scale and the five pentatonic scales used in many Scotch tunes that can be played on the black keys of the piano This meaning, therefore, involves a host of modern ideas of tonality, relationship, and the like, laboriously taught to the musician, which he can scarcely avoid carry-

* Formerly professor of Physics at the University of Michigan, afterwards for over twenty years an examiner of musical instrument applications in the U S. Patent Office.

ing over to scales of primitive peoples, the word "pentatonic" suggests a precision not often warranted by our knowledge of primitive music and not involved in the English term "five-tone" or "five step" I wish the word and the word "natural" might be banished from the literature of early music

It has just been implied that our knowledge of early music is very incomplete and the voluminous literature on the subject is very unconvincing We may note five reasons for this condition

(1) Among most if not all civilized peoples the arts were prehistoric and were attributed to Gods or heroes, by the time men were ready to form theories, if they ever reached that stage, the early steps were forgotten, to our generation some of the probable steps are suggested by existing instruments of primitive people

(2) Because of contradictory or erroneous statements of writers, as the fable of Pythagoras's hammers, the alleged Arab scale of thirds-of-a-tone, or the Hindu scale of quarter tones Boethius's writings confused European musicians for a thousand years

(3) The ingrained conviction of the ordinary musical writer that our common diatonic scale, given by the white keys of a well-tuned piano or organ, is a natural scale and that every performer aims to use it The result is that generally a transcription of exotic music is colored and falsified by extraneous harmonic associations as truly as a landscape is changed when one looks at it through colored glass Many illustrations might be cited, for example, the pianist who some thirty years ago accompanied the first troupe of Fisk Jubilee Singers to England told me that some of their songs could not properly be accompanied by the piano because they are not in the piano scale Professor Fillmore (1) after adding harmonies to Miss Fletcher's transcriptions of American Indian songs finds some "curious results" which he catalogues, then he adds "These points cover pretty much the whole ground of modern harmonic structure"!

(4) Many of our musical terms have or have had two or more meanings, and terms taken from the Greek are often confusingly changed in meaning, the words scale, harmony, enharmonic are illustrations

(5) The lack of a suitable notation The present one carries inevitably harmonic associations that disguise a simple melody written in it The scientific staff in occasional use for more than a century has thirteen lines to the octave Since these are too numerous to be distinguished readily, alternate lines may be omitted, the result corresponds to Debussy's whole-tone scale and to the Janko key-board, to identify lines, letters (clefs) may be added, or those lines may be drawn heavier that correspond either to the ordinary staff or to the black keys of the piano This staff corresponds to the piano-scale with its equal steps and is ideal for scientific purposes Of course no one imagines it will ever displace the present staff with its wealth of printed music

These are some of the causes of the failure of the histories of music in past centuries against which the modern scientific student must guard himself

A new era began with the publication in 1863 of Helmholtz's famous work on the *Sensations of Tone as a Physiological Basis for the Theory of Music*, the English translation of which appeared in 1875 This was a great stimulus to the scientific study of music and led to many controversies with musicians, the latter, as artists, rightly resented the dicta of some scientific men saying "Thou shalt" or "Thou shalt not," but their denials of the results of scientific research sometimes revealed pitiable ignorance We now see that his theory of harmony as based on harmonic over-tones and beats was not adequate and was not so much a universal explanation as a justification of the music and the instruments of his day

The new materials now in the twentieth century at one's disposal include several great collections of instruments with catalogs of most of them, several treatises on non-European music, especially translations of Oriental writings, great collections of phonographed records of primitive music and transcriptions of them, notably of American Indian songs by Miss Frances Densmore, published by the United States Bureau of Ethnology (2), and of Asiatic and African people by Dr Hornbostel of Berlin, which are scattered through various journals, also Balfour's monograph (3) on the musical bow and Sach's on Egyptian instru-

ments (4) and Lavignac's *Encyclopédie* (5), Bingham's brief paper (6) in the *Psychological Bulletin*, 1914, gives an admirable summary and bibliography of recent progress

Before we discuss these and other materials at our disposal, consider the state of mind in which one should approach the problems of exotic music Some observers and writers seek to show how much it has in common with our music, they treat music as a universal language, in spite of familiar incidents to the contrary, as the aversion of most hearers to music not of their familiar type, or the inability of the singers at the Munich opera house to learn some of Wagner's music, so that preparations for the performance of it had to be abandoned

But a more liberal and scientific state of mind is possible In the presence of an unfamiliar instrument or picture or description of one, the serious student should try to answer the questions "What did the maker of this instrument do?" (defining the result by numbers and measures) and "Why did he do it?" The serious attempt to answer these questions will develop the sympathetic attitude which is characteristic of culture as truly as classical studies are supposed to do Many of the ordinary writings on far-away music are not only unscientific but unsympathetic, dogmatic and illiberal

Assume now that we have before us a great collection of early or primitive instruments or pictures of them

Consider first the instruments of the flute type, distinguished from simple whistles by the fact that several sounds of different pitch may be drawn from each of them For present purposes it is immaterial whether the vibrations are excited by blowing across the open end of the tube, or across a hole in the side of the tube, or by using a mouth-piece, or a single reed like the clarinet or a double reed like the oboe Such instruments are found all over the world The tube may be cylindrical or conical, the important feature for present purposes is the series of holes burned or bored along the side, their location depends in part on the relative lengths of the tube and the player's arm, if the tube is very long the lowest hole is often at a considerable distance above the lower end of the tube Now it seems a very

obvious thing to produce a sound by blowing in the end of a tube as a hollow plant stem (Lucretius says they whistle in the wind) and to get other sounds by making holes in the sides of the tube and likewise obvious to stop these holes by the fingers No great degree of intelligence is needed to take these steps But the next step shows intelligence — the application of older ideas of artistic satisfaction due to repetition of similar designs This led to locating the holes of the flute at equal distances, a definite fixed succession of sounds could then be produced which may clearly be called a scale, but it was unlike any modern European scale, for the successive intervals became greater as the notes became higher In other words the specific audible results were a secondary result or a by-product of a construction made to appeal to the eye (7) This view has been adopted and developed by Hornbostel (9)

A modified type of the construction has the holes in two groups, the distance between the groups being greater than that between adjacent holes Both types are widely distributed over the earth, from the pipes taken from Egyptian tombs to the bamboo or pottery tubes of modern primitive people Varieties of these flutes are illustrated in a paper of mine published by the Smithsonian Institution in 1902 (7) The number of holes would naturally be six, three for each hand, while the double flutes would have three or four holes After men had acquired ideas of a definite standard scale, this primitive scale was corrected by varying the location of the holes and changing their diameters, so the flute became a complicated thing until a century ago Boehm reconstructed it

Going back to Egyptian times we may note that the end-blown long-flute is figured on a tablet older than the first dynasty, which is dated by Breasted as beginning about 3400 B C (4) The double oboe and clarinet appear about 2700 B C Loret (5) has collected data regarding nearly fifty actual instruments in the museums of Europe, many have the holes at substantially equal distances and it is doubtful if any of them give our scale except accidentally

Another wind instrument of extreme interest comprises an

air chamber with a whistle-mouthpiece and a few openings that may be closed by the fingers No formula is found for this in text books on acoustics One form of this has come down from early Chinese times The most beautiful specimens are from Costa Rican graves and are now in the Washington museum (7) These are of pottery in a crude bird-shape and have four finger holes, in the best specimen these holes are acoustically equivalent, so only five sounds can be produced, viz, F, A, C, D, E, or do, me, sol, la, si A formula was deduced that involves the square root of the sum of the diameters of the uncovered openings, the computed pitch agrees with the observed pitch to one-eighth of a semi-tone It will be observed that the successive intervals decrease as the pitch rises, also that if the finger holes have unequal diameters, the pitch will depend on which openings are uncovered, so with only four finger holes sixteen notes are possible but nine is the greatest number found Here, as with the flutes, the holes are located in a symmetrical way and evidently form a design But observe that a score of these instruments substantially alike to the eye may furnish a score of sensibly different series of notes, the idea of a standard pitch and of one or a few standard series of notes had not yet developed, there is here no scale under the third definition above

To turn to the string instruments, probably no one doubts that they have developed from the hunting bow Balfour has collected figures showing forms of the "musical bow" from all parts of the world Many of them have gourd resonators or other means of strengthening the sound, and some I think show means for readily varying the tension and so the pitch The subsequent steps in the development have not yet been systematically traced, two of them were

Putting two or more strings on one bow,

Fastening two or more bows side by side, each bow having its own string

The results of development along this line were the harps and lyres In the harps the strings were of different lengths and so the compass of the instrument might be much greater than that of the lyre, but the harps of classical times have no front pillar

and so the total tension on the strings must have been small Several forms of harps are shown on the monuments as in use by the Egyptians — the bow-harp, stutz-harp, shoulder-harp, angle-harp (4)

In the lyres (including the Greek *cithara* and *phorminx*) the strings were of nearly equal length, but the diameter and tension of the strings doubtless were varied to produce a scale The Egyptian lyres generally appear to have been held with the strings extending away from the player, but among the Greeks the strings were nearly upright

One would like to know about the tuning of these instruments, but there is little told us, there was no standard pitch corresponding to our A of 435 vibrations or the Chinese Lu What appear to be tuning pegs like ours were generally only pegs to wedge the strings into a hole, so precision of tuning was impossible and it is questionable whether the crude strings under a slight tension would give notes whose scale-relations were clear, even if the player had somehow learned of definite relations

The one instrument that could furnish a standard series of intervals is the guitar or lute, this is widely found throughout the world and has been developed in the violin to be a most important instrument It comprises (*a*) a resonance body, box, sounding-board, or belly, (*b*) a rod or neck extending from one end of the body, (*c*) one or more strings attached to the belly and neck lying parallel to the neck and near enough to it so that any of them can be pressed against it by the player's finger and the vibrating length be determined Many forms of the instrument have points marked by the maker or tuner whereat the strings are to be stopped These markings are called frets, like the borings on flutes, they are sometimes found equally spaced This is the case in the lute which appears on a Babylonian monument as early as 2500 B C and on an Egyptian one about 1500 B C Strangely the lute was practically unknown to the Greeks

But I have no doubt that it was by the lute or the acoustically similar monochord that the numerical relations were obtained, 8/9, 3/2, etc , which Ptolemy and many followers have given and which are credited to Pythagoras though he probably learned

them in Egypt One who desires to know how an old-time musician used these instruments to give definite scales may read Land's French translation of Al-Farabi's Arabic treatise of about 1000 A D

The remaining points that there is time to speak of may best be connected with a chronological chart (Chart exhibited) We take Egypt as furnishing the longest and best time scale among the ancient states, indicating the dynasties and years when certain instruments appear in the records, for comparison a few other events are noted The Sumerians had the long-flute and the lyre before 4000 B C , the Chinese claim a date of about 2700 B C , the Homeric period is put at about 1300 B C , — about half-way from the date of the Sumerian record to our own time, Pythagoras came about 600 B C and most of the Greek writers on music between 200 B C and 200 A D It will surprise most people to see how far Greece was from the beginning musically

The more one studies the long history of music the more he will hope that the archaeologists may find an inscription or manuscript that will throw light on the way the ancients came to fix on three, four or seven strings for the lyre

ANN ARBOR, MICHIGAN

BIBLIOGRAPHY

1 Peabody Museum, Harvard Archaeol and Ethnol Papers, 1893

2 Bureau of Amer Ethnol, Bulletins 45, 53, 61, 75, 80 Washington, 1910–1923

3 BALFOUR, H The Natural History of the Musical Bow Oxford, 1899

4 SACHS, CURT Die Musikinstr des alten Aegyptens Berlin, 1921

5 LAVIGNAC, A Encycl de la Musique Paris, 1914–1922

6 BINGHAM, W V Five Years of Progress in Comparative Musical Science Psychol Bull, Vol XI, No 11 Nov, 1914.

7 WEAD, C K Contributions to the History of Musical Scales. U S Nat'l Museum, Rept for 1900 Washington, 1902

8 LAND, J P N Recherches sur l'Histoire de la Gamme Arabe Congr Intern des Orientalistes Leyden, 1885

9 Zeitschrift für Ethnologie Berlin, 1911, p 603

GENETIC FACTORS FOR YELLOW ENDOSPERM COLOR IN MAIZE*

E G ANDERSON

YELLOW endosperm color has long been used in genetic studies in maize But it early became evident that more than one genetic factor is frequently involved East (1910) observed 15-to-1 ratios and reported two factors for yellow These factors were assumed to give yellows of equal or nearly equal intensity, the two combined giving a deeper yellow Emerson (1911) reported two factors for yellow, one for deep or golden-yellow, the other for pale yellow White (1917) has reported a factor for white endosperm which is dominant to yellow The influence of endosperm texture on endosperm color has probably been recognized by all who have worked on yellow endosperm, even where no mention of it is made in their papers The difference in color in reciprocal crosses due to the diploid nature of the polar nucleus has been recognized in most of the later reports The terminology used by different writers has not been uniform and has led to some confusion

In order to use yellow endosperm effectively in linkage studies, it was necessary to know more definitely the factors dealt with In addition to checking up the yellow endosperm factors present in the writer's own cultures, tests were made with yellow types from other sources A comparison of the yellows supplied by several workers made it possible to eliminate some of the confusion due to differences in terminology

TESTS

In addition to types from other sources, a number of yellow strains were selected from the writer's cultures and others from

* Paper from the Department of Botany of the University of Michigan, No 206, reporting research conducted by the author while holding appointment as National Research Fellow in Biology

Dr R A Emerson's cultures, in an effort to get types showing different intensities of yellow and differences in clearness of segregation into yellow and white All were crossed with white endosperm, dilute purple plants (*y b Pl*) The hybrids were then crossed with pollen from white endosperm sun-red plants (*y B pl*) in order to test for linkage with the *Pl* factor for plant color (Emerson, 1921) Recessive *b* factor in the hybrid gave less purplish coloration in the pericarp than the dominant *B*, thus enabling the separations of endosperm colors to be made more easily The dominant *B* factor was introduced in the outcross in order to facilitate the separation of plant colors in the field

The results of this series of tests can be stated in a very few words All the deep yellows showed linkage with *Pl* These yellows are almost certainly due to the same yellow factor, *Y*, which had been previously shown to be linked with *Pl* (Emerson, 1921) The pale yellows tested have shown no linkage with *Pl* No further work has been carried on to test for identity among the pale yellows

Among the yellows tested were the two used by Babcock and Collins (1918) under the names of "amber" and "yellow" These correspond to the yellow and pale yellow of Emerson (1911) and others The yellow used by White (1917) in tests with the dominant white factor is also a pale yellow No material was available from East's early work (1910) in which he discovered the presence of two factors for yellow His data are readily interpreted on the basis of a deep and a pale yellow such as are usually present in yellow dent varieties

Tests on the dominant white factor have shown it to be dominant to the deep yellow Dominance is, however, not complete Tests on the linkage relations of this factor are in progress

THE KNOWN FACTORS FOR YELLOW ENDOSPERM COLOR

At the present time three genetic factors for endosperm color in maize are sufficiently well known to be used in linkage tests and other genetic studies The terminology given here is in common use among most workers in maize genetics

Y — Yellow — This dominant factor gives the deep yellow to orange-yellow endosperm color found in nearly all yellow varieties of maize Dominance is incomplete, the heterozygous forms being lighter in color than the homozygous dominant The hybrid $y \times Y$ is lighter in color than the reciprocal $Y \times y$ This has been explained by the fact that the endosperm is triploid in constitution, the polar or endosperm nucleus of the embryo sac being diploid The Y factor for yellow endosperm has been shown to be linked with the following genetic factors, *Pl* (Emerson, 1921), *sm* (Anderson, 1921), *pm*[1] (Eyster, 1924) W_5 (Demerec, 1923), W_6 (Demerec, 1923) and W_1 (Stroman, in press, also Lindstrom, 1923)

Yp — Pale yellow — This factor, also dominant, gives a pale or light yellow color This yellow, in addition to being more dilute than the deep yellow, also differs in being a clear or lemon-yellow, never approaching orange- or amber-yellow No data showing any linkage with pale yellow have been published It is, however, known to be linked with a factor for pale-green seedling color (unpublished data of Dr M Demerec)

Wh — Dominant white endosperm color — It is dominant to both deep and pale yellow, but dominance is not complete No linkage data are available

In addition to the three factors listed there are others which may well be classed as modifying factors Chief among these are the factors affecting endosperm texture The hard translucent endosperms of the flint and pop corns become a much more intense yellow than do the soft opaque starchy or flour corns The intensity of color is also very much affected by the waxy and sugary conditions of endosperm texture There is some evidence of rather pronounced endosperm color modifiers not related to any obvious differences in endosperm texture Since, however, these factors are hardly adapted for use as aids in further genetic work, it has not been thought worth while to devote further time and energy toward their analysis

University of Michigan

[1] In the text of Dr Eyster's paper *pm* was incorrectly stated to be linked with pale yellow The F_2 data presented are from dihybrids of constitution *Y y Pm pm Yp Yp*

LITERATURE CITED

ANDERSON, E G 1921 The Inheritance of Salmon Silk Color in Maize Cornell University Agricultural Exp Sta, Memoir 48 535-554

—— 1922 Heritable Characters of Maize Fine Streaked Leaves Journ Heredity, 13 91-92

BABCOCK, E B, AND COLLINS, J L 1918 Genetics Laboratory Manual, McGraw-Hill Book Co, New York

DEMEREC, M 1923 Inheritance of White Seedlings in Maize Genetics, 8 561-593

EAST, EDWARD M 1910 A Mendelian Interpretation of Variation that is Apparently Continuous Amer Nat, 44 65-82

EMERSON, R A 1911 Latent Colors in Corn Ann Rept Amer Breeder's Assn, 6 233-237

—— 1921 The Genetic Relations of Plant Colors in Maize Cornell Univ Agric Exp Sta, Memoir 39 1-156

EYSTER, W H 1924 A Primitive Sporophyte in Maize Amer Journ Bot, 11 7-14

LINDSTROM, E W 1923 Genetical Research with Maize Genetica, 5 327-356

WHITE, O E 1917 Inheritance of Endosperm Color in Maize Amer Journ Bot, 4 396-406

FOMES FRAXINEUS FR IN CULTURE *

DOW V BAXTER

It is known that *Fomes fraxineus* (Plate III) is a rare plant in the United States Atkinson (1) reported the fungus as being entirely confined to ash, occurring on the European ash in Europe and on our native ash species in the United States Lloyd (8) writes that it occurs on ash, apple and locust in Europe, where the fungus is said to be common In this country, Kauffman (7) reports the fungus in Michigan on ash It has since been seen in this state on oak and maple In all cases the collections were found on stumps, and so the fungus is regarded as a true saprophyte In addition to Michigan, Overholts (12) records it for Ohio, Illinois and Iowa, as occurring usually on ash Murrill (11) reports it from New York and Louisiana in addition, and also states that it occurs on trunks and stumps of sweet gum and peach

THE IDENTITY OF *FOMES FRAXINEUS* FR

Fomes fraxineus has been frequently confused with other fungi Von Shrenk (16) discusses this plant on ash along with *Fomes fraxinophilus* in connection with his work on the decay of white ash Speaking first of *F fraxinophilus*, he says "There is some question as to what name ought to be given to this fungus" He adds further "In view of the fact that the only European specimens of *Polyporus fraxineus* available do not agree with the present fungus, it is deemed best to retain the name given by Professor Peck (i e *P fraxinophilus*) for the present It may be necessary to make it a synonym of *Polyporus fraxineus* after a further comparison with European material" We now know

* Paper from the Department of Botany of the University of Michigan, No 213

that Von Shrenk was correct in retaining the name for the fungus he studied, and in the meanwhile *F fraxineus* has become well known in the United States

Lloyd (8) in referring to *Fomes fraxineus* says "We take it in the sense that it has become established by use, although not correct historically, for *Fomes fraxineus* originally with its colored pores, was no doubt the same as *Fomes ulmarius* It is closely allied to ulmarius and has been generally confused Berkeley seems to have been the only one who appreciates the real difference He called the plant *Fomes cytisinus*, which in justice is the correct name for it"

THE SPOROPHORE

The applanate pileus is incrusted with a hard upper layer The surface of the fruiting body is whitish in young growing plants, but the color darkens to brown or may even become blackish with age The flesh-colored context is decidedly of a punky or corky nature, and the way in which it separates is a very conspicuous feature when a fruiting body is broken apart The tubes when occurring in layers are indistinctly stratified In the collections studied they are for the most part confined to one layer near the outer portions of the sporophore, but in older parts and near the point of attachment, they show this stratification The plants are distinctly perennial The pores are round and number about four to six per millimeter The spores, as reported in the literature, are subglobose, smooth and subhyaline They are said to measure 5×5–6 microns No cystidia are present

The fruiting body of *Fomes fraxineus* is in itself very distinct and is readily recognized in the field The dimidiate or imbricate habit of growth and the glabrous and often tuberculate applanate pileus in addition to the pinkish context are distinctive characteristics The morphological differences, particularly in the length of tubes and the shape of the pileus, distinguish it from the only other species of this genus in Michigan having a rose-colored context, namely, *Fomes roseus* This latter species, too, is known only on conifers, while *Fomes fraxineus* is confined to frondose wood

THE ARTIFICIAL CULTURE OF OTHER SPECIES OF THE GENUS FOMES

The genus Fomes has perhaps received less attention in cultural investigations than any other group of fungi as large, and as widely and commonly distributed throughout the temperate regions. Few genera are of more importance to forest pathology than the one under consideration. Since the time of Brefeld's (2) studies of *Fomes applanatus*, *F. fomentarius*, *F. pinicola*, *F. igniarius* and others, few species of this genus have been cultured. In recent years, however, some very excellent papers have been published. White (17) succeeded in culturing *Fomes applanatus* from spore to spore under artificial conditions. Long and Harsch (9) cultured several species of this genus. They found in their work that the vegetative characters of many wood-destroying fungi distinctly aid in determining the identity or casual organism of a given rot.

These authors conclude that differences found in cultures may be used to establish the independence of species. Faull (4), somewhat earlier, compared cultures of *Fomes officinalis* to those of *Polyporus sulphureus*, as these two fungi produce similar decays in many respects. Humphrey (5) has conducted a series of durability tests on Greenheart with seven species of the genus Fomes and other basidiomycetes. Schmitz (13) determined the enzyme action of *Fomes igniarius* with material grown in pure cultures and he also worked with *Fomes roseus* in another connection (14). Schmitz and Daniels (15) made decay tests of coniferous woods with cultures of *Fomes pinicola*.

METHODS USED FOR *FOMES FRAXINEUS*

The fruit bodies of *Fomes fraxineus* were found in November while in an excellent growing condition on *Acer saccharinum*. The material was brought immediately into the laboratory from the field and studied. In all culture work it was found that fresh sporophores proved most useful. In this condition, tissue taken from the fungus is most likely to continue growth on artificial

media, and the dangers from contamination are considerably lessened

The fruit bodies were washed in sterile distilled water several times and were handled with sterile forceps A sterile scalpel[1] was used to remove the exterior portions from a section of the sporophore, and the general "tissue method" as described by Duggar (3) was employed A portion of the context was placed on previously sterilized malt-extract agar in petri dishes The fungus mycelium produced from this inoculum was used as stock material As large quantities of agar were required for culturing other wood-destroying forms, the same medium was used in the work with *Fomes fraxineus* Malt extract agar[2] was found to answer the requirements both from the standpoint of technique and growth of the fungus After many tests were made in order to determine the best concentration of the malt-extract, it was found that, within limits, concentration was not as important a factor as it might at first seem The amount used influenced mainly rapidity of growth, depending somewhat on moisture and temperature conditions For general purposes, however, the following formula was found most adapted for this use

25 grams agar agar
25 grams malt-extract
1000 c c distilled water

In other work where decayed wood was used (when the material was placed in the petri dishes), the substance dried out before the mycelium had time to make growth In such cases it is very important that the inoculum be transferred to sterile distilled

[1] In later work, razor blades were found more convenient These were dipped in corrosive sublimate solution and were heated over a flame until dry just before using The blades were not heated enough to burn the fungus This process avoided a delay in waiting for scalpels to cool Speed was an important factor in such work since the sporophores were uncovered during the operation

[2] Oatmeal agar was also a very suitable medium for *Fomes fraxineus* The agar was easily prepared and the fungus grew rapidly on this medium The formula given by Pethybridge and Murphy (*Sci Proc Dub Soc*, 13 580 1913) was used Sixty grams of Quaker oats were ground, and added to a liter of water containing *agar* Three per cent agar was usually used in this work

water contained in small capsules before planting on the agar This process results in little danger from contamination and the growth of the fungus is frequently hastened

Fomes fraxineus started growth in about a week after the sporophore tissue was placed on the agar From such a culture small portions of the mycelium were later transferred to sterilized wide-mouth Erlenmeyer liter flasks containing a thick slant of the agar already described One liter of agar made four or five slants The value of a readily prepared medium when a large number of cultures are made is evident The flasks were placed in a dimly lighted culture-room kept slightly below room temperature After the mycelium had covered the surface of the agar, wood blocks were placed in these culture flasks

These blocks were obtained from white ash heart-wood so selected as to be free from defects The blocks measured $\frac{3}{8} \times \frac{3}{8} \times 2\frac{1}{2}$ inches The size of the blocks selected was determined by the ease with which they could be transferred under sterile conditions to the flask, and the necessity of making due allowance for swelling of the wood when wet In some species this varies more than in others The size of the block also obviously had to do with the possibilities of contamination of the wood, the larger the block, the greater the danger

After the wood on all faces of the block had been labelled with a soft lead pencil, the wood was dried to a constant weight in a drying oven In other work it had been found necessary to keep a book record of each block put in the flasks in order to avoid error The pencil marks, in the case of some species of wood, are difficult to see after the blocks have decayed Pencil labels on such light-colored woods as white ash, however, usually show plainly even if the block is considerably affected by rot The drying of the wood to a constant weight and the recording of the weight is unnecessary where the rate of decay is not the object of the experiment On the other hand, the drying process increased the efficiency of sterilization and so was practiced in all work

The blocks were then placed in large glass capsules, two to a capsule, and about 250 c c of water was added The amount of

water used in such work may be arbitrarily determined after sterilization trials with the various species of wood to be tested The capsules were autoclaved for three and one-half hours at fifteen pounds pressure

The blocks were then removed individually from the capsules by means of a long chrome-nickel needle flattened into a spatula form, and transferred to the flasks The blocks were easily placed in the flask and on the actively growing mycelium in such a position that the maximum amount of space was conserved They could also be placed in any desired position in the flask, i e , the wood could be inoculated on a transverse or the longitudinal surface This arrangement of the blocks was readily manipulated under sterile conditions by the spatula-like transferring needle A small amount of sterile distilled water was then added to each flask.

When the cultures were ready to be opened, the wood was removed from its position in the flask by a long wire The wire was bent in the form of a rake No difficulty was experienced in removing the mycelium and the blocks as they readily separated from the agar Likewise, the mycelium surrounding the blocks separated in sheets or mats almost completely, leaving the wood in an excellent condition for study

DISCUSSION OF THE METHOD

It will be seen from the foregoing description that this culture work is varied from older methods in use The blocks are not sterilized in the flasks and inoculated later Instead, the separately sterilized wood blocks are placed uniformily on pure mycelial cultures of the wood-destroying fungus The advantages of such modifications are

(1) the disposition of the blocks in the flasks as desired,
(2) the uniform inoculation of the wood blocks,
(3) an actively growing inoculum,
(4) the moisture conditions in the flask

In the first place, results obtained may depend somewhat on the disposition of the blocks in the flasks All blocks may be placed in such a position that they will be inoculated from the

same surface This is important since in previous tests it was found that hyphae may penetrate the blocks more readily on the cross-section end A more superficial growth may form when the block is inoculated on its other surfaces Secondly, the even inoculation of the wood blocks is essential in order to compare results obtained from various cultures, especially in durability tests In cases where the blocks have been placed in flasks, sterilized, and then inoculated, the wood may remain several weeks or even for longer periods (depending somewhat on the fungus) before the mycelium may reach the wood in the culture In some cases, perhaps exceptions, the blocks may not become inoculated at all Humphrey (6) working with *Lentinus lepideus* Fr states "In computing the actual period of test it should be kept in mind that from three to four weeks are required to get a uniform infection after the inoculations are made" Schmitz and Daniels (15) in their studies of coniferous woods say "An effort was made to locate the inoculum in the center of the group of blocks The fact is of course appreciated that by this method of inoculation the blocks in the center of the group may become infected first and may be well along the road to decay before the mycelium comes in contact with the blocks in the periphery of the group" The method described here avoids the difficulty experienced by these workers If a block is placed on the mycelium, the test period begins almost at once, and this period is the same for all wood in the flask

A third advantage of the method is that the mycelium is well nourished at the time of inoculation The best conditions for continued growth of the fungus have been established A fourth and very distinct advantage of the method has to do with the moisture relations during the period in which the fungus is grown All investigators working with wood-inhabiting fungi have realized that the control of the moisture is a difficult problem, since the cultures must be kept going for a protracted period Excellent moisture conditions have prevailed, by the use of this method, in many cultures of other wood-destroying fungi, such have been kept going over a year without the extra addition of water Additional water may be added, however, at the beginning of the experiment if it is deemed necessary

The disadvantages of opening up cultures for watering are many In the first place, the dangers from contamination are ever present, but this factor can be avoided by careful manipulation Secondly, the operation is time-consuming where many cultures are involved Of greater importance, however, is the impossibility of distributing equally the moisture throughout the culture when the water is added afterwards Flooding almost invariably occurs if enough water is added, a condition that cannot be easily overcome It disturbs the rate of growth of the fungus as well as the moisture relations between the interior of the blocks and the atmospheric conditions in the flask Again, flooding may cause a more luxuriant growth of the mycelium on the surface of the blocks, instead of favoring a penetration of the hyphae into the wood Such disturbances, which hinder the comparative value of durability tests, are avoided in this method

CULTURES

The foregoing method has proved very satisfactory for the culture of wood-inhabiting fungi such as *Fomes "Ellisianus"* (*F fraxinophilus*), *Fomes fraxinophilus*, *Polyporus hispidus*, and others Plates VI–VIII show cultures of these fungi obtained by this method

The growth-behavior of *Fomes fraxineus* (Plates IV–V) strikingly reveals the characteristics of the fruiting body in color and texture In color, the hyphae are at first snow white, but later change to "cartridge buff" (Ridg) and then to "pale pinkish buff " In old cultures the color may change to "pale pinkish vinaceous " The mycelium on the agar as well as in the wood cultures soon forms a tough felt-like growth consisting of coarse intricately woven hyphae In the wood cultures, the mycelium envelops the blocks with a leathery sheet which thickens upon further growth of the fungus

It is well known that many wood-destroying organisms are not as rapid in their growth on agar as fungi of other groups Vegetative growth of *Fomes fraxineus*, however, is not slow It is possible that this fact may be correlated with its distinctive

saprophytic habits in nature. A comparison of the rate of mycelial growth in a radial direction of this fungus with other polyphores is given in the following table.

RATE OF RADIAL GROWTH IN CENTIMETERS OF *FOMES FRAXINEUS* COMPARED WITH OTHER WOOD-DESTROYING FUNGI IN PETRI DISH CULTURES

Name of Fungus	13 Days	20 Days	25 Days
Fomes fraxineus	1.5	2.9	4.1
Fomes Ellisianus *	.4	.9	2.6
Fomes fraxinophilus	.4	1.2	2.7
Fomes Everhartii	.5	1.3	1.6
Polyporus hispidus	.5	1.3	2.0
Poria obliquiformis	.7	1.7	2.2

* The name *Fomes Ellisianus* is used here to distinguish the fungus obtained on *Shepherdia argentea* from *Fomes fraxinophilus* on white ash. *Fomes Ellisianus* is considered a form of *Fomes fraxinophilus*.

In large flasks the same general relations hold for the rapidity of growth. Special attention is called to the growth-rate of the first three forms. It is to be seen from the table that *Fomes fraxinophilus* and *Fomes Ellisianus* (*F. fraxinophilus*) show practically the same amount of vegetative growth for twenty-five days. *Fomes fraxineus* is seen to grow faster in culture. Thus physiological as well as morphological differences separate *Fomes fraxineus* from *Fomes fraxinophilus*.

Former investigations with species of the Polyporaceae have brought out the interesting fact that these plants usually fail to produce typical pilei in culture. Some fungi form the so-called abortive sporophores which assume various positions with reference to the substratum, others produce a continued vegetative growth. Other fungi, of which *Fomes fraxineus* is an example, produce in culture a pore surface characteristic of the genus Poria. In this species round pores similar to those found in the sporophores were formed in petri dish cultures. These pores first form as small depressions irregularly distributed

over the surface Sections of the pore surface revealed subglobose spores in abundance After some difficulty in determining the manner in which they were borne, it was found that they were secondary spores These spores measured 5–7 × 5–6 microns It is interesting to note that these measurements are the same, or practically the same, as those given in the literature for the basidiospores of this species Microscopic sections from the tube layer of the sporophores showed the presence of bodies similar to those obtained by culture

Such facts demonstrate the necessity of a more thorough study of the hymenium and its structure, and more careful measurements of attached spores in fresh sporophores It is not unlikely that many measurements have been in error because of the confusion of secondary spores and basidiospores While polymorphism has been demonstrated among the basidiomycetes by Brefeld (2), Lyman (10) and others, a great amount of work remains to be done in this field Weather conditions may influence the kind of spore-formation in the sporophore It is possible that under certain seasonal conditions secondary spores may entirely replace the hymenial mode of reproduction in some of these basidiomycetes In all work of this nature the value of checking field identification by laboratory studies is apparent

Little attention was given to the decay produced by *Fomes fraxineus* Fungi which are rare or uncommon are not the forms which usually cause serious losses in timber supplies The mycelium of this fungus in culture rapidly covered the blocks, but its action on the wood, after three months' time, was not striking The mycelium was somewhat difficult to distinguish in wood during the early stages of decay because of its hyaline nature The hyphae, although not especially abundant in the elements, ramified the vessels in particular, and were observed in all other cells, the medullary rays, the wood parenchyma, and the wood fibers Only a very slight delignifying action was noted in the tests made for lignin and cellulose [3] The black lines which

[3] The tests used for lignin and cellulose were made with the usual reagents, phloroglucin and hydrochloric acid, and chloro-zinc-iodide

occur in hardwoods decayed by such fungi as *Fomes igniarius* and others were absent in the blocks, and no mottling effects so characteristic of certain forms of decay occurred in the wood

UNIVERSITY OF MICHIGAN

LITERATURE

1 ATKINSON, GEORGE F 1908 Observations on Polyporus Lucidus Leys, and Some of its Allies from Europe and North America Botanical Gazette, 46 322

2 BREFELD, OSCAR 1889 Untersuchungen aus dem Gesammtgebiete der Mykologie VIII Basidiomyceten, III 1 305 Leipzig

3 DUGGAR, B M 1905 The Principles of Mushroom Growing and Mushroom Spawn Making U S Dept Agr, Bur Pl Ind Bull, 85 1–60

4 FAULL J H 1916 Fomes officinalis (Vill), A Timber-Destroying Fungus Transactions of the Royal Canadian Institute, Toronto, XI 185–209

5 HUMPHREY, C J 1915 Tests on the Durability of Greenheart (Nectandra rodiaei Schomb) Mycologia 7 204–209

6 HUMPHREY, C J 1916 Laboratory Tests on the Durability of American Woods I Mycologia, 8 85

7 KAUFFMAN, C H 1908 Unreported Michigan Fungi for 1907, with an Outline of the Gasteromycetes of the State Report of the Michigan Academy of Science, 10 63–84

8 LLOYD, C G 1915 Synopsis of the Genus Fomes, p 230

9 LONG, W H, AND HARSCH, R M 1918 Pure Cultures of Wood-Rotting Fungi on Artificial Media Journal of Agricultural Research, XII No 2 33–82

10 LYMAN, G R 1907 Culture Studies on Polymorphism of Hymenomycetes Proceedings of the Boston Society of Natural History, 33 No 4 125–209

11 MURRILL, W A North American Flora, 9 96

12 OVERHOLTS, L O 1915 The Polyporaceae of the Middle Western United States Washington University Studies, III, Part I, No 1 60

13 SCHMITZ, HENRY 1921 Studies in Wood Decay II Enzyme Action in Polyporus volvatus Peck and Fomes igniarius (L) Gillet Journal of General Physiology, III No 6 795–800

14 Schmitz, Henry 1921 Concerning the Durability of the Wood of the Maiden Hair Tree, Ginko biloba. Journal of Forestry, 19 165–166

15 Schmitz, Henry, and Daniels, A S 1921 Studies in Wood Decay I School of Forestry of the University of Idaho Bull, No 1 1–11

16 Von Shrenk, Hermann 1903 A Disease of the White Ash Caused by Polyporus Fraxinophilus U S Dept Agr, Bur Pl Ind Bull, 32 13

17 White, J H 1919 On the Biology of Fomes Applanatus (Pers) Wallr Transactions of the Royal Canadian Institute, Toronto, pp 133–174

PLATE III

Fruiting Body of Fomes fraxineus Fr

PLATE IV

Petri Dish Cultures of FOMES FRAXINEUS Fr showing Stages of Pore Formation

PLATE

FIG. 1

FIG. 2

Flask Cultures showing Mycelium of FOMES FRAXINEUS growing on White Ash Wood

The Culture of Fig. 1 is Three weeks old

PLATE VI

FIG. 1. Flask Culture of FOMES ELLISIANUS Anderson showing Hymenophore Tubes

FIG. 2. Tube Cultures of FOMES FRAXINOPHILUS showing Pore Formation

The cultures of Fig. 2, which are two months old, are growing in the light [illegible]

PLATE VII

FIG. 1. Fruiting Body of FOMES ELLISIANUS Anderson (*Fomes fraxinophilus* Ell.) on *Shepherdia argentea*

FIG. 2. FOMES ELLISIANUS (*Fomes fraxinophilus*) growing on Blocks of *Shepherdia argentea*

The [illegible]

PLATE VIII

FIG. 1. FOMES EVERHARTII Ellis & Gallister, growing on Poplar Blocks Already Decayed by *Fomes igniarius*

FIG. 2. POLYPORUS HISPIDUS growing on Apple Wood

Note black lines forming on wood

THE RELATIONSHIPS OF THE ASCOMYCETEAE, BASIDIOMYCETEAE AND TELIOSPOREAE

ERNST A BESSEY

THE investigations of Kniep, Rawitscher, Bensaude and others, in the last ten years, have strengthened the view, long held by most mycologists, of the essential unity of the Higher Fungi The close parallelism of the nuclear behavior in the ascus, teliospore and basidium has been shown to be accompanied by other points of similarity which make it impossible to avoid the conclusion that these are homologous structures Whether we follow the majority of mycologists and include the rusts and smuts within the Class Basidiomyceteae, or, recognizing their differences, remove them from that class as a separate class, the Telioporeae, the relationship remains undoubted

It may not be improper, then, to venture into the realm of speculation as to the phylogeny of these classes Whence did they arise? Which class gave rise to which? What phylogenetic arrangement within each class will best indicate the probable lines of descent?

Many years ago Sachs, among other German botanists, pointed out features of similarity between certain Ascomyceteae and the Florideae, viz , possession of trichogynes and the development of numerous sporogenous threads from the oogone intermingled with sterile threads also, the two sets of threads forming the fungus fruit, as they do the red seaweed cystocarp Upon the discovery by Stahl of the fertilization of Collema by non-motile sperms borne by water to the elongated trichogyne, and by subsequent investigators of the fact that the higher fungi have their cross walls perforated as do those of the Florideae, the idea of the possible origin of the Ascomyceteae

from floridean ancestors became rather generally accepted and is now held by probably the majority of botanists Atkinson in 1915, a most keen student of fungi, repudiated this idea, while others have mentioned it as a possibility, but have considered it to be a matter of mere idle speculation The present writer in 1913 and Dodge in 1914 have advocated the theory of the origin of Ascomyceteae and Florideae, while Church in 1921 prefers to consider these two groups to have had a more or less parallel development from some common ancestor lost in the mists of antiquity

There are enough points of difference between the Ascomyceteae and the Florideae to make it impossible, at present, to say that the former arose from any known order of the latter No attempt will be made to enter into that problem The point for consideration now is that of determining what are the more primitive features, phylogenetically, of the Ascomyceteae Clearly these must be those which they possess in common with their seaweed relatives These are production of non-motile sperms, possession of trichogynes, abundant development of sporogenous hyphae from the fertilized oogone, and the development of a spore-fruit made up of two categories of hyphae, the sporogenous (ascogenous) hyphae and sterile hyphae, the former being outgrowths of the oogone, the latter arising apart from but mostly near to the oogone

These conditions are all met in some of the Ascomyceteae, but not in the Basidiomyceteae nor in the Teliosporeae, although these two classes, as mentioned at the beginning of this paper, are certainly closely related to the Ascomyceteae The latter must then be placed first in the series of the Higher Fungi

As pointed out by the author in 1913 and by Church in 1921, the Laboulbeniales exhibit most fully the characters listed above as primitive They are true Ascomyceteae and show that the ascus-producing habit must have arisen long ago, perhaps, as Church suggests, even before the loss of chlorophyll compelled the ancestral plants to adopt a parasitic habit, which for this order is upon insects This group appears to have given rise to no other groups, or in other words, it forms a "blind alley"

Church has called attention to the fact that, structurally, they resemble very greatly juvenile forms of Florideae which have developed their sexual organs precociously They do not form a true mycelium, nor is the fruit comparable to a true perithecium, but resembles much more the protective layer surrounding the procarp in some of the red seaweeds The trichogyne varies from a simple unbranched rod-like structure separated from the oogone by only a single cell to a many-celled and very copiously branched organ The sperms, at least in some species, appear to be naked

Another group of Ascomyceteae possessing primitive characters is that of the apothecial lichens, the Order Lecanorales Some of these, like Collema, possess functional trichogynes and non-motile sperms and give rise to a large cluster of ascogenous hyphae from the oogonial cell Each apothecium seems to arise from a single fertilized oogone The oogone is one cell of a coiled structure characteristic of many of the Ascomyceteae, called the ascogonium, while the trichogyne is a long, slender, many-celled, unbranched thread The ascogonium is far less like the carpogonial branch of the red seaweeds than is the corresponding structure in the Laboulbeniales The parasitism of the lichens upon algae would, of itself, serve to indicate a more primitive type of organism than those which are saprophytic or parasitic upon land plants We should expect an aquatic form, upon becoming parasitic, to use for its hosts either water animals, as the Laboulbeniales did for insects, or algae

Church believes that lichens have arisen from marine ancestors, once autotrophic, but which, becoming heterotrophic and losing their outer photosynthetic layers of cells, have picked up intrusive algae to recover vicariously photosynthetic relations with the free atmosphere " The extremely variable morphological structures of the lichens are supposed by him to represent the interior portions of the ancestral autotrophic forms It is noteworthy that the different types of lichen thallus do, in fact, match up very well with the various types of structure of Florideae if the photosynthetic layers of cells are removed from the latter

Even within the Lecanorales there is much variation in the sexual reproduction In Collemodes the trichogyne is intrathallic and grows directly to the sperm which remains attached to the antheridial branch, which is also within the thallus In other lichens the trichogyne is short and apparently not functional

The close similarity of the structure of the apothecium of some Pezizales to the apothecium of Lecanorales leads one to believe that the latter have given rise to the former by the reduction of the thallus to a simpler filamentous form, the adoption of a mostly saprophytic habit, and the enlargement and frequent compounding of the apothecium Ascobolus, some of whose species have a massive coiled ascogonium terminated by a long, multi-septate trichogyne which seeks out the antherid, Lachnea with a shorter pluriseptate trichogyne and Pyronema with a non-septate trichogyne represent steps of development toward the total elimination of the trichogyne In this order, also, there are cases where the trichogyne and antherid do not come in contact, as shown by W H Brown, and cases where no antherid is formed at all Under both these conditions the many nuclei in the oogone pair off with one another in the same manner as the nuclei of male and female origin usually pair off

From the Pezizales, evolution seems to have taken place in several directions Partially subterranean genera have given rise through forms like Genea and Hydnocystis to the typical Tuberales, through forms like Rhizina the typical Helvalles are connected The Phacidiales are probably offshoots of the Pezizales or of some of the ancestral lichens The Exoascales are probably much reduced apothecial forms to be derived from some leaf-inhabiting member of the Pezizales with a rather diffuse apothecium The Hysteriales are possibly developed from Pezizales in which the small apothecium has become laterally compressed Many points about their structure, however, show a parallelism, if not indicating descent from some of the perithecial forms, while it must not be forgotten that there are some lichens with a Hysterium-like type of fruit Whether these hysteriaceous lichens are the primitive ancestors of the

Hysteriales, or represent a newly acquired habit of parasitism on algae should be given consideration also

The perithecial series may have arisen in the perithecial lichens, the Pyrenulales, or possibly the perithecium is a more recent development from the apothecium arising independently in the two orders Lecanorales and Pezizales respectively The writer inclines toward the first mentioned view, that the perithecial lichens have given rise to the other perithecial forms, in which case the apothecium and the perithecium would both be very early developments in the Class Ascomyceteae, perhaps even antedating the loss of the autotrophic algal habit Indeed, Dodge has shown the great similarity of the perithecium to some of the cystocarps of certain Florideae It should be noted that the coiled ascogonium with elongated trichogyne is found in some of the perithecial forms which have not the lichen habit, in many cases there are produced also structures similar to the spermagonia of lichens Whether these sperms and trichogynes are actually functional is, in some cases, uncertain In other cases they are known not to be functional Another type of sexual organ is also abundant among perithecial forms, consisting of a short, intertwined pair of hyphae, the one ascogonial, the other antheridial in function In some cases the antheridial member of the pair seems to be lacking

In the lack of fuller knowledge as to the sexual organs of most of these perithecial forms any arrangement must be rather tentative Furthermore, the recent studies which have led to the establishment of the Order Pseudosphaeriales and to the Order Hemisphaeriales have gone far enough to show that they may lead to a great disruption of the Order Sphaeriales as now recognized when these same methods of study are applied to all of the forms within that order Whether some of the families of the Pyrenulales ought to be interspersed with the non-lichen forms awaits further study Furthermore, the distinction between Sphaeriales and Hypocreales breaks down in the families Melanosporaceae and Sordariaceae Indeed, the two "orders" show such similarity in sexual organs, structure of perithecium, and the like, that it seems probable that these two orders will

eventually be merged In that case similar groups will be placed side by side differing only in the color and consistency of the perithecium

Until these different orders mentioned above have received further careful study, the following very tentative arrangement can be followed From the Pyrenulales will be derived the non-stromatic Sphaeriales and Hypocreales These give rise to forms with submerged perithecia and finally to those in which the perithecia are enclosed within highly organized stromata Thus forms like the family Xylariaceae would be placed near the apex of development of the Sphaeriales with Melanosporaceae and Sordariaceae near to the base By loss of a perithecial wall distinct from the enclosing stoma have arisen the Pseudosphaeriales and from these the Dothideales By loss of the lower part of the perithecium have developed the Hemisphaeriales

All of the foregoing orders normally possess ostiolate perithecia By loss of the ostiole and by increased emphasis on the superficiality of the mycelium the Order Perisporiales arose from the simpler Sphaeriales Either from the Perisporiales (a view supported by the method of formation of the catenulate conidia in both orders), or possibly from the Pseudosphaeriales, arose the Aspergillales with their closed perithecia containing the asci scattered throughout the body of the perithecium in small chambers, instead of clustered at the sides or base of a large cavity, as in the Sphaeriales and Perisporiales By the loosening of the perithecial walls can be derived such forms as the Gymnoascaceae From the last mentioned family by a great reduction in the asci resulting from the sexual act we can derive such forms as Eremascus and Endomyces in the Order Saccharomycetales From these two filamentous forms the step to the one-celled yeasts is very short

It will be seen that in the foregoing arrangement such simple forms as Eremascus and the probably related Dipodascus, etc , are considered not as primitive Ascomyceteae, but as the members of the group furthest away from the primitive type If these are considered as primitive the development of trichogynes and free, non-motile sperms is a hard thing to explain, while the reverse process as suggested in this paper is comparatively simple

To turn to the Class Teliosporeae and to give consideration to the question as to which are the most primitive, the rusts or the smuts, the following points must be considered The typical Uredinales possess a life-cycle in which there is a definite stage for the sexual fusion of the cells, followed by a typical binucleate type of mycelium with a definite stage where nuclear fusion occurs Furthermore, a structure is always present, the pycnium, that is morphologically identical with the spermagonium of the lichen The Ustilaginales, on the other hand, possess no spermagonium, a sign perhaps, of less primitiveness, and the sexual fusion of cells giving rise to the binucleate type of mycelium is not uniformly at one point of development in different genera, or even in different species of the same genus The young teliospore is binucleate, the two nuclei fusing at maturity, in most smuts, but even this binucleate condition of the young teliospore is lacking in some species, e g , in the strain of *Ustilago avenae* studied by Flerov When we take into consideration the substituted types of cell fusion or methods of acquiring the binucleate mycelial type, and even the possible lack of binucleate teliospores in some smuts as well as the absence of the spermagonium, it seems reasonable to look upon the smuts as fungi that have progressed further from the ancestral condition than the rusts, although it is not necessary to look upon the smuts as directly descended from the rusts Probably, indeed, that is not the case, but they must have had common ancestry

If the rusts are the more primitive, in certain respects anyway, which genera or families of rusts are the more primitive and what connection, if any, have they with the Ascomyceteae? It must be noted that some genera, at least, in each of the three or four recognized families of Uredinales, possesses the complete life-cycle pycnium, aecium, uredinium, telium and promycelium with sporidia Each genus or group of closely related genera with complete life-cycle has associated with it other genera in which one or more stages are omitted These omitted stages may be the aecium, or the uredinium, or both In each case of omission of the aecium the sexual union of cells is postponed until the next spore type, so that in some rusts the sexual union

occurs just prior to the formation of the teliospore The nuclear union, on the other hand, normally occurs in the teliospore That the pycnium must represent some very ancient and deep-seated inheritance is evidenced by the fact that it almost never fails to develop, even though, so far as we know, it has no present function Since the aecial and uredinial stages are, in general, the same except for minor details in all the families of rusts and the teliospores, however much they differ in form, undergo the same nuclear phenomena, it is difficult to believe that the short-cycle rusts can be the more primitive and that the nearly related long-cycle rusts have developed the full life-cycle independently a great many different times from the many different genera of short-cycle rusts The conclusion seems inevitable that the long-cycled Uredinales are the more primitive, at least of the rusts that we now know Of these the forms with stalked teliospores are agreed by all uredinologists to be more highly specialized, so that we will have to look to some other family than the Pucciniaceae for the more primitive rusts Such specialized forms as Cronartium with the waxy column of spores seem less primitive than the crust-like forms such as Melampsora Whether these must be regarded as more primitive or the forms with teliospores scattered throughout the mesophyll of the host leaf can not be decided at present However, the latter include certain of the fern rusts which in some other respects, also, are considered by Arthur to be primitive in character

What were the ancestral forms of these rusts like, and what are the homologies of their different structures? The spermagonia or pycnia of the rusts are possibly to be considered as the homologues of the spermagonia of the lichens and some Sphaeriales, but with their function lost, as appears also to be the case in some of the Sphaeriales, at least Such reduced forms as Endophyllum and Kunkelia perhaps suggest what some of the more primitive rusts were like In these the chain of aeciospores becomes a chain of teliospores because of the fact that the nuclei fuse instead of remaining distinct It seems possible that the aecium represents a very much modified apothecium or perithe-

cium with the chains of aeciospores corresponding to the ascogenous hyphae. In the primitive rusts probably these aeciospores were teliospores, which in their turn were modified asci. By the insertion of one type of repeating spore, aeciospore and a second type of repeating spore, the urediniospore, the sporogenous hyphae of the aecium no longer bear teliospores but these are borne on the hyphae arising from the repeating spores. The teliospore with its early binucleate condition, the fusion of the nuclei, the reduction division and the formation of four haploid nuclei show such close similarity to ascus that the added fact of its origin from a hypha of binucleate cells arising from a fusion of two cells makes it impossible to avoid homologizing ascus and teliospores. The ascus produces internal spores which are set free by the stretching and rupture of the ascus. The teliospore stretches, and on the elongated surface thus produced there develop external spores. It is possible that the condition in Coleosporium represents a step in the modification of the ascus into teliospore.

In Coleosporium the promycelium is not produced as an outgrowth from the teliospore, but the latter after its nucleus has undergone reduction division is divided by cross walls into four cells. This is spoken of as an internal promycelium. From each of these cells there is budded off through the external wall of the teliospore a sporidium. If this actually does represent a more primitive type of teliospore, then these four cells of the "internal promycelium" could be considered as four ascospores within an ascus, ascospores which are not set free but which germinate *in situ* by the formation of a conidium, the sporidium. It is well known that in many cases ascospores do germinate within the ascus. It must be admitted, however, that the very close similarity even as to aecial hosts, aside from the great similarity of teliospore structure between Melampsora and Coleosporium, suggests that possibly Coleosporium has arisen from Melampsora by the suppression of the external promycelium. Indeed it would be hard to explain the origin of the promycelium in the smuts which certainly are related to the rusts if we assume that the primitive rusts had a promy-

celium like that of Coleosporium, unless we assume that the Coleosporium condition is an atavistic structure, for surely the common ancestors of rusts and smuts must have had external promycelium It seems likely that Janchen's suggestion is correct that the non-septate promycelium such as is found in the Family Tilletiaceae is more primitive than the septate type as found in the Ustilaginaceae and in most of the Uredinales

Were it not for the persistence in the Uredinales of the origin of the binucleate stage at a definite point in the life-cycle (aecium) and for the occurrence of the spermagonium (pycnium), it would be fairly easy to derive the Teliosporeae from certain of the order Auriculariales This is the suggestion of Janchen, being a reversal of the ordinary arrangement in which the smuts and rusts are supposed to represent the types ancestral to the Auriculariales It is difficult, however, in spite of forms like *Jola* and *Septobasidium Bogoriense,* to see how any of the known Auriculariales could have given rise to Uredinales or Ustilaginales, for the Auriculariales possess clamp connections which are lacking in rusts and smuts, and, still more important, there are no structures from which the rusts could have derived their pycnia and aecia Possibly we have here a case in which the Auriculariales and Teliosporeae are divergent branches from some ascomycetous ancestor without any close connection to any of the other Basidiomyceteae

The studies by Kniep and his pupil Lehfeldt, and of Miss Bensaude, have demonstrated the homology of the process of formation of the clamp connection in the true Basidiomyceteae with that of the crozier formation in the young ascus They have, furthermore, demonstrated the fact that the mycelium arising from a single spore consists of uninucleate cells which form no clamp connections, and that at some stage there arises a type of mycelium possessing binucleate cells and clamp connections Miss Bensaude has shown that in a species of Coprinus this arises by the fusion of a uninucleate conidium derived from one single spore culture with a uninucleate mycelial cell developed from the germination of a different spore Thenceforward the cells are binucleate and produce clamp connections Lehfeldt

has demonstrated hyphal fusions followed by the production of binucleate cells and clamp connections In rare cases the basidiospore itself is binucleate and gives rise directly to binucleate cells with clamp connections

We have thus a deviation from the conditions in most of the Ascomyceteae in which at least a definite oogone (or ascogonium) is produced, even where the trichogyne has been lost and where the antherid is lacking Janchen has pointed out that the non-septate basidium of the true Basidiomyceteae is of several types (1) with the four nuclei in a longitudinal row, the basidiospores being produced laterally in a longitudinal row as in Tylostoma, (2) with the four nuclei in a longitudinal row but with the basidiospores developed at the apex of the basidium, (3) with the four nuclei all at one horizontal level and the basidiospores produced at the apex Types 1 and 2 are found in the Gastromyceteae, Type 3 is found in the Hymenomyceteae and some of the Gastromyceteae The Order Tremellales also is of Type 3 except that the basidium is divided longitudinally into four parts by septa at right angles to one another Janchen derives Type 1 from a four-spored ascus in which the spores are formed externally instead of internally Four-spored asci are not at all uncommon, but we know of no cases where they are now giving rise to external spores because when they do that they are not asci but basidia

The Gastromyceteae with their closed spore fruits containing usually numerous hymenial chambers lined with basidia show all transitions, through secotium-like forms to the Agaricaceae, where the spaces between the radiating gills are homologous to the hymenial cavities of the Gastromyceteae In many respects the subterranean or partially subterranean Hymenogastrales show a suggestive parallelism of structure to some of the Tuberales, and it is suggested as a possibility that some of the Tuberales, many of which have but four spores in the ascus, may have developed by mutation from ascus-producing to basidium-producing forms Whatever their origin the Hymenogastrales form an extremely variable stock from which have doubtless arisen, on the one hand, the Sclerodermatales, another

direction the Phallales, in still another direction the Lycoperdales with the Nidulariales as an offshoot, and finally through the Secotium-like forms the Agaricales The Agaricaceae would then represent the most primitive of the Hymenomyceteae From these the line of evolution has passed by various divergent lines to Boletaceae, Polyporaceae, Thelephoraceae, Hydnaceae and Clavariaceae Probably from some form of Thelephoraceae perhaps related to Corticium, has arisen the Order Exobasidiales By a somewhat parallel development some of the fleshy forms perhaps of the Clavariaceae or Thelephoraceae have, accompanied by a partial or complete splitting of the basidium, given rise to the Orders Dacryomycetales and Tremellales respectively

To revert to the Auriculariales, these show a remarkable similarity in form of spore fruit to the two orders last mentioned, but show a type of basidium that is entirely different It seems best to the writer to consider the external form as more or less an accident of parallel development, and to look to another origin for Auriculariales in some ascomycete that is a common ancestor to this order and to the Uredinales and Ustilaginales

In the accompanying chart (Fig 3) the suggestions made in this paper are shown in graphic form A few orders are omitted and in some cases a choice of two lines of ancestry is shown This does not indicate that the group is believed to be polyphyletic, but that the ancestry is doubtful, being in the author's opinion most likely one or the other of the alternatives offered

Michigan Agricultural College
East Lansing, Michigan

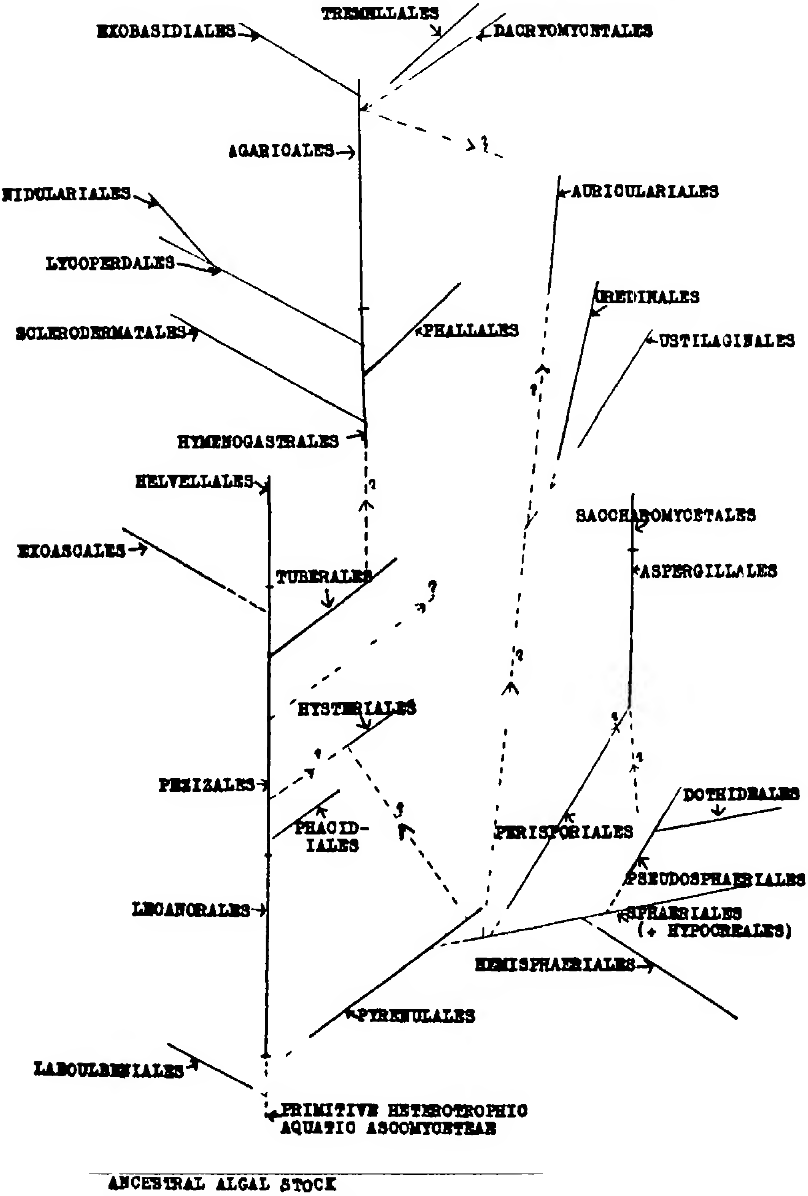


FIG 3 Phylogenetic Arrangement of Orders of Higher Fungi

LITERATURE CITED

ATKINSON, GEO F 1915 Phylogeny and Relationships in the Ascomycetes Ann Mo Bot Gard, 2 315–376 Figs 1–10

BENSAUDE, MATHILDE 1918 Recherches sur le Cycle Évolutif et la Sexualité chez les Basidiomycètes Pp 1–156 6 Pls, 30 figs (*Thesis*)

BESSEY, ERNST A 1913 Some Suggestions as to the Phylogeny of the Ascomycetes Mycol Centralb, 3 149–153

BROWN, WM H 1915 The Development of Pyronema confluens var inigneum Amer Journ Bot, 2 289–298

CHURCH, A H 1921 The Lichen Life-Cycle Journ Bot, 59 139–145, 164–170, 197–202, 216–221

DODGE, B O 1914 The Morphological Relationships of the Florideae and the Ascomycetes Bull Torr Bot Club, 41 157–202 Figs 1 13

FLEROV, B 1923 Sur la Cytologie de l'Ustilago Avenae Pers d'après les Cultures in Vitro Travaux de la Section de Mycologie et de Phytopathologie de la Société Botanique de Russie, 1 23–36 Pl 3 (*In Russian*)

JANCHEN, ERWIN 1923 Die Stellung der Uredineen und Ustilagineen im System der Pilze Oesterreichische Bot Zeitschr, 72 164–180, 302–304 Pl 11, 1 fig

KNIEP, HANS 1915 Beiträge zur Kenntnis der Hymenomyceten III Zeitschr f Bot, 7 369–398 Pl 2, Figs 1–20

LEHFELDT, WERNER 1923 Über die Entstehung des Paarkernmycels bei heterothallischen Basidiomyceten Hedwigia, 64 30–51 Pl 1, 4 figs

PARAVICINI, EUGEN 1917 Untersuchungen über das Verhalten der Zellkerne bei der Fortpflanzung der Brandpilze Ann Mycol, 15 57–96 Pls 1–6, Figs 1–5

RAWITSCHER, F 1912 Zur Kenntnis der Ustilagineen Zeitschr f Botanik, 4 673–706 Pl 8, Figs 1–20

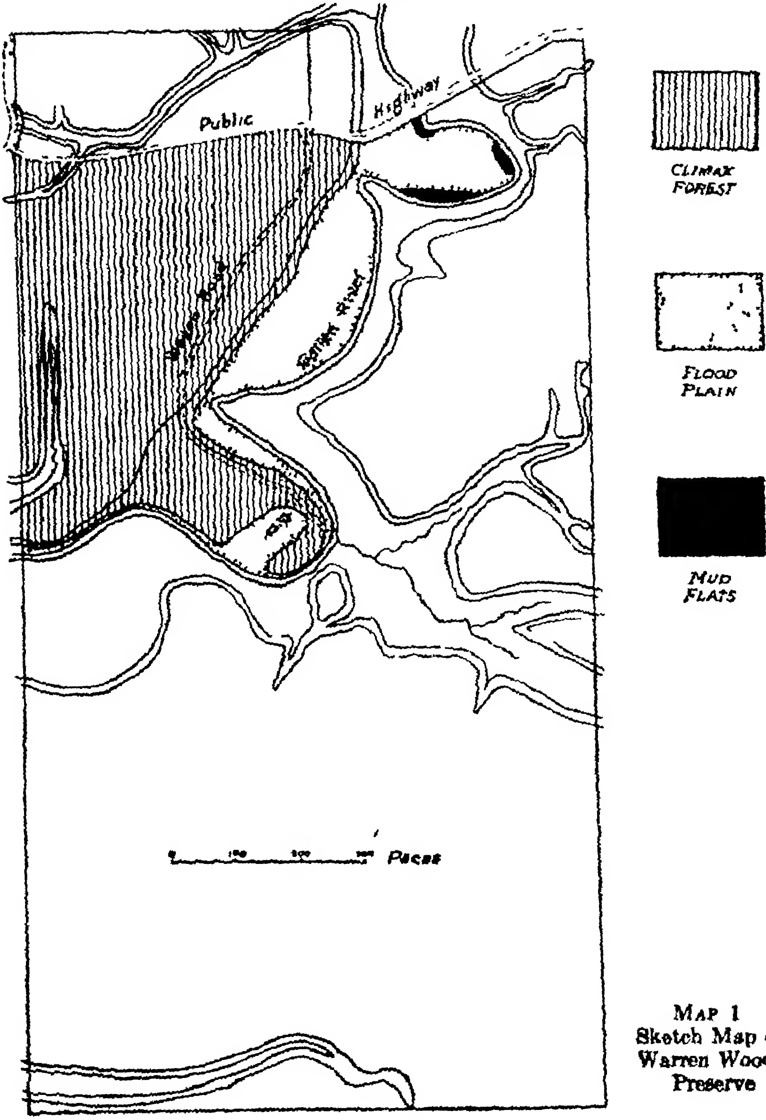
SACHS, JULIUS 1874 Lehrbuch der Botanik (4te Auflage)

THE FLOWERING PLANTS AND FERNS OF WARREN WOODS, BERRIEN COUNTY, MICHIGAN

CECIL BILLINGTON

THE Warren Woods are located in Berrien County, Michigan, about three miles north of Three Oaks They are a part of the Edward K Warren Foundation established by Mr and Mrs E K Warren of Three Oaks, Michigan The woods includes one of the largest areas of original hardwood timber existing in the southern part of the state It has never been lumbered or burned over and many of the trees are magnificent specimens, being from fifty to seventy-five feet to the first limbs and from two to four feet in diameter

The accompanying map of the woods indicates the area covered by the list of species The preserve is about two hundred acres in extent, of which approximately one half has been cleared and cultivated as farm lands, the remainder being mostly covered with forest The Galien River enters the north end of the woods and flows in a general southerly direction through the wooded area where it turns to the west, forming a broad bend before it leaves the western edge of the forest Only that portion north and west of the Galien River was studied, for the reason that the balance of the preserve had been heavily pastured by cattle and horses The herbage was almost entirely destroyed and the shrubs and young trees badly broken and eaten The stock apparently had never crossed the river to the west side, and as soil, drainage and other conditions are substantially the same on both sides of the river, this list may be fairly said to represent the flora of the entire wooded portion of the preserve No attention was paid to the part which had pre-



MAP 1
Sketch Map of
Warren Woods
Preserve

The three habitats and the portion of the woods studied are indicated. The remainder of the preserve was either being heavily pastured by cattle and horses or had been previously cultivated and was not examined

viously been cultivated, so that the portion examined comprises approximately fifty acres

The area examined may be separated into three well defined habitats the Climax Beech-Maple Forest, the Flood-Plain, and the Mud-Flats

THE CLIMAX FOREST
(Plates IX, X, XI, Fig 3)

This division comprises the greater portion of the woods It is comparatively level and some twenty feet or more above the flood-plain area A small ravine cuts in at the north and a larger one in the southwest, the banks of which provide admirable habitats for several species of ferns The whole area is dominated by the beech and the sugar maple There are also a few oaks, elms, ash, wild cherry and whitewood scattered throughout The trees are very large and the shade is dense There are only a few small trees, mostly young beeches and maples For the most part the forest floor is quite open, but in sections these small trees form dense thickets under which there is little or no herbage In some sections the papaw also forms a dense underbrush Spice bush, maple-leaved viburnum, alternate-leaved dogwood and flowering dogwood may also be mentioned as underbrush The ground is heavily covered with decaying leaves, and for the most part conditions ordinarily found in deciduous woods prevail This provides a very favorable habitat for the early spring flowers, and such deep woods favorites as spring beauty, phlox, hepatica, squirrel corn and Dutchman's breeches are abundant There are several small low places in which water stands until midsummer, providing around their edges suitable places for a number of species of sedges, ferns, etc These natural habitats are varied to some extent by the uprooting of trees by the wind and by a wagon road which traverses the entire woods Where the natural conditions have been disturbed by the uprooting and taking out of trees, thistles, dandelions, wild lettuce, burdocks, and other cosmopolitans are quick to enter Similarly the wagon road has introduced to the forest many plants which would not otherwise have been in evidence The forest is bordered on the

west by cultivated fields and a number of species have invaded the woods from this source But for the most part the portion of the forest north and west of the Galien River is practically in its original condition and is no doubt as satisfactory for the study of the native flora as can be found in southern Michigan today

THE FLOOD-PLAIN

(Plates IX, XI, Fig 2)

Below the level of the climax forest and bordering the Galien River for nearly its entire distance through the woods is the flood-plain This is also densely forested and the entire area is in deep shade Prominent trees of the flood-plain are the sycamore, basswood, soft maple, red maple, butternut, hackberry and willow The thorns make up the greater portion of the small tree growth, but ironwood, red bud and wild crab are also frequent The underbrush on the flood-plain is comparatively sparse and composed for the most part of spice bush, American bladdernut and buttonbush This latter species occurs in buttonbush swamps, low places where water stands until late in the summer, providing suitable habitats for iris, sedges and ferns In some portions the herbage is very dense and tall, and others sparse Practically the entire flood-plain area apparently is subject to flooding by the spring freshets and the list of species reveals several annuals which are no doubt more or less transient on account of this fact

THE MUD-FLATS

(Plate XI, Fig 1)

Upon my first visit to the woods in July, 1919, I found three small mud-flats, or mud-bars, in the bends of the Galien River These had apparently been washed up by the river earlier in the same season The soil was soft mud and fine sand, and being continually damp furnished a suitable germinating place for a great variety of seeds, the result being that at the time of my first visit they bore a flora of no mean proportions, including seedling poplars, maples, willows and elms, as well as many

grasses, sedges and flowering plants The first season the plants were, for the most part, back away from the water next to the flood-plain, the outer edge being comparatively bare, but in the succeeding seasons of 1920 and 1921 practically the entire bars were covered by plants, and except for the difference in their level and the absence of large trees, these mud-flats could scarcely be distinguished from the flood-plain proper Considering their very limited area the list of species of these mud-flats seems to comprise an unusually large and varied vegetation

The field work upon which this report is based was carried out in three trips to the woods, as follows July 26 to 30, 1919, September 11 to 13, 1920, and May 18 to 21, 1921

So far as possible duplicate specimens were procured of all species, one of which has been deposited with the Herbarium of the University of Michigan and the other with the Michigan Agricultural College

For so small an area the portion of Warren Woods studied yielded an abundant flora, the list of species comprising seventy-nine families, two hundred and three genera and three hundred and fifty-eight species and varieties No doubt a more extended survey covering an entire season would reveal others The flood-plain has a great many hawthorns, but at no time when I was at the woods did any but the four species listed have either flowers or fruit, the shade apparently being too dense to permit of their free fruiting

The list of species comprises at least one not previously reported from Michigan, *Uniola latifolia* Michx In this locality it is approaching the northern limits of its range Heretofore *Carex crus-corvi* Shuttlw , according to Beal's *Michigan Flora*, was known in only two localities It grew abundantly in a small buttonbush swamp on the flood-plain Also the grass, *Diarrhena diandra* (Michx) Wood , given by the same authority as rare, was found on the flood-plain in considerable quantities at the south end

The nomenclature used is that of Gray's *New Manual of Botany* (seventh edition) The work was supported by the Mich-

igan Geological and Biological Survey and was done under the direction of Dr A G Ruthven in connection with a general biological survey of this portion of Berrien County Much help was given by Mr George R Fox, director of the Warren Foundation, in getting to and from the woods, and many other courtesies freely extended by him during the three trips are gratefully acknowledged Many thanks are also due to Mr Oliver Atkins Farwell, to whom doubtful specimens were submitted, and for valued assistance in checking the list of species, and to Dr J H Ehlers, who reviewed the genus Rubus I am also indebted to Lee R Dice for use of the map prepared by him for his article on the mammals of the woods and to the Museum of Zoology, of the University of Michigan, for the cut of the Mud-flat, which had previously appeared in one of its publications

LIST OF SPECIES

POLYPODIACEAE (Fern Family)

1 Phegopteris hexagonoptera (Michx) Fée Beech Fern Climax forest, occasional

2 Adiantum pedatum L Maidenhair Climax forest, occasional

3 Asplenium angustifolium Michx Climax forest, occasional

4 Asplenium acrostichoides Sw Climax forest, abundant

5 Polystichum acrostichoides (Michx) Schott Christmas Fern Climax forest, frequent

6 Aspidium Thelypteris (L) Sw Marsh Shield Fern Climax forest, low places

7 Aspidium noveboracense (L) Sw New York Fern Climax forest, abundant

8 Aspidium spinulosum (O F Müller) Sw var intermedium (Muhl) D C Eaton Climax forest, abundant

9 Cystopteris fragilis (L) Bernh Fragile Fern Climax forest, low places

10 Onoclea sensibilis L Sensitive Fern Climax forest, low places

11 Onoclea Struthiopteris (L.) Hoffm. Ostrich Fern. Flood-plain, found in only one buttonbush swamp.

OSMUNDACEAE (Flowering Fern Family)

12 Osmunda regalis L. Flowering Fern. Climax forest, flood-plain, low places, abundant.
13 Osmunda Claytoniana L. Interrupted Fern. Climax forest, frequent.
14 Osmunda cinnamomea L. Cinnamon Fern. Flood-plain, occasional.

OPHIOGLOSSACEAE (Adder's Tongue Family)

15 Botrychium obliquum Muhl. Climax forest, rare.
16 Botrychium obliquum Muhl. var. dissectum (Spreng.) Clute. Climax forest, rare.
17 Botrychium virginianum (L.) Sw. Rattlesnake Fern. Climax forest, frequent.

EQUISETACEAE (Horsetail Family)

18 Equisetum arvense L. Common Horsetail. Mud-flat.
19 Equisetum hyemale L. var. intermedium A. A. Eaton. Flood-plain, mud-flat, occasional.

ALISMACEAE (Water-plantain Family)

20 Sagittaria latifolia Willd. forma obtusa (Muhl.) Robinson. Arrow-head. Mud-flat, flood-plain, only two or three plants found.
21 Alisma Plantago-aquatica L. Water Plantain. Mud-flat.

GRAMINEAE (Grass Family)

22 Digitaria humifusa Pers. Small Crab Grass. Mud-flat.
23 Digitaria sanguinalis (L.) Scop. Crab Grass. Mud-flat.

24 Panicum capillare L Old-witch Grass Mud-flat

25 Panicum clandestinum L Mud-flat, flood-plain, occasional

26 Echinochloa crusgalli (L) Beauv Barnyard grass Mud-flat, flood-plain, occasional

27 Setaria glauca (L) Beauv Foxtail, Pigeon Grass Mud-flat

28 Leersia virginica Willd White Grass Mud-flat, flood-plain, occasional

29 Milium effusum L Millet Grass Climax forest, frequent

30 Oryzopsis asperifolia Michx Flood-plain, occasional

31 Oryzopsis racemosa (Sm) Ricker Climax forest, occasional

32 Muhlenbergia mexicana (L) Trin Mud-flat

33 Muhlenbergia Schreberi J F Gmel Drop-seed, Nimble Will Mud-flat

34 Brachyelytrum erectum (Schreb) Beauv Climax forest, frequent

35 Agrostis perennans (Walt) Tuckerm Thin Grass Climax forest, occasional

36 Cinna arundinacea L Climax forest, flood-plain, mud-flat

37 Sphenopholis pallens (Spreng) Scribn Climax forest, occasional

38 Eragrostis hypnoides (Lam) BSP Flood-plain, mud-flat, forming dense mats

39 Melica striata (Michx) Hitchc Climax forest, frequent

40 Diarrhena diandra (Michx) Wood Flood-plain, plentiful in a small area at the south end

41 Uniola latifolia Michx Spike Grass Flood-plain, rare Approaching its northern limit and not heretofore reported from Michigan

42 Dactylis glomerata L Orchard Grass Climax forest, in and by the side of wagon road through forest

43 Poa annua L Low Spear Grass Climax forest, in wagon road

44 POA PRATENSIS L June Grass, Kentucky Blue Grass Climax forest

45 POA SYLVESTRIS Gray Climax forest, frequent

46 POA ALSODES Gray Climax forest, frequent

47 GLYCERIA NERVATA (Willd) Trin Fowl Meadow Grass Climax forest, low places, flood-plain, abundant in low places, mud-flat

48 FESTUCA NUTANS Spreng Climax forest, flood-plain, occasional

49 BROMUS CILIATUS L Climax forest, low places

50 BROMUS ALTISSIMUS Pursh Flood-plain, low places

51 BROMUS INCANUS (Shear) Hitchc Flood-plain, frequent

52 ELYMUS BRACHYSTACHYS Scribn & Ball Flood-plain, abundant

53 HYSTRIX PATULA Moench Bottle-brush Grass Climax forest, flood-plain, occasional

CYPERACEAE (SEDGE FAMILY)

54 CYPERUS ESCULENTUS L Mud-flat

55 ELEOCHARIS ACICULARIS (L) R & S Mud-flat

56 SCIRPUS ATROVIRENS Muhl Mud-flat

57 CAREX MIRABILIS Dewey Climax forest, low places

58 CAREX BRUNNESCENS Poir Climax forest, edge of low places

59 CAREX BROMOIDES Schkuhr Climax forest, low places

60 CAREX DEWEYANA Schwein Climax forest, occasional

61 CAREX ROSEA Schkuhr Climax forest, flood-plain, frequent

62 CAREX ROSEA Schkuhr var MINOR Boott Climax forest, flood-plain, less frequent than the type

63 CAREX CEPHALOPHORA Muhl Climax forest, bank of ravine

64 CAREX SPARGANIOIDES Muhl Climax forest, low places

65 CAREX CONJUNCTA Boott Flood-plain, rare

66 CAREX STIPATA Muhl Mud-flat

67 CAREX CRUS-CORVI Shuttlw Flood-plain, found only in one buttonbush swamp, rare

68 CAREX CRINITA Lam Climax forest, low places, flood-plain

69 CAREX VIRESCENS Muhl Climax forest, rare

70 CAREX VIRESCENS Muhl var SWANII Fernald Climax forest, rare

71 CAREX DAVISII Schwein & Torr Flood-plain, dense shade, rare

72 CAREX GRACILLIMA Schwein Climax forest, frequent

73 CAREX GRACILLIMA Schwein var HUMILIS Bailey Climax forest, rare

74 CAREX JAMESII Schwein Climax forest, rare

75 CAREX PENNSYLVANICA Lam var LUCORUM (Willd) Fernald Climax forest, abundant

76 CAREX PUBESCENS Muhl Climax forest, frequent, flood-plain, rare

77 CAREX PRASINA Wahlenb Climax forest, low places, rare

78 CAREX PLANTAGINEA Lam Climax forest, frequent

79 CAREX CAREYANA Torr Climax forest, rare

80 CAREX LAXICULMIS Schwein Climax forest, frequent

81 CAREX DIGITALIS Willd Climax forest, infrequent

82 CAREX LAXIFLORA Lam Climax forest, frequent

83 CAREX LAXIFLORA Lam var GRACILLIMA Boott Climax forest, flood-plain

84 CAREX LAXIFLORA Lam var PATULIFOLIA (Dewey) Carey Climax forest, frequent

85 CAREX LAXIFLORA Lam var VARIANS Bailey Climax forest, occasional

86 CAREX LAXIFLORA Lam var BLANDA (Dewey) Boott Flood-plain, occasional

87 CAREX LAXIFLORA Lam var LATIFOLIA Boott Climax forest, frequent, flood-plain, occasional

88 CAREX HITCHCOCKIANA Dewey Climax forest, frequent

89 CAREX GRISEA Wahlenb Climax forest, frequent, flood-plain, frequent

90 CAREX ARCTATA Boott Climax forest, frequent

91 CAREX LUPULINA Muhl Flood-plain, frequent in low places, mud-flat,

92 Carex Grayii Carey Climax forest, low places, frequent, flood-plain, low places, frequent

93 Carex intumescens Rudge Climax forest, flood-plain, less frequent than the following variety

94 Carex intumescens Rudge var Fernaldii Bailey Climax forest, low places, frequent

95 Carex Tuckermani Dewey Climax forest, low place, rare

ARACEAE (Arum Family)

96 Arisaema triphyllum (L) Schott Indian Turnip, Jack-in-the-Pulpit Climax forest, frequent, flood-plain, frequent

97 Arisaema Dracontium (L) Schott Green Dragon, Dragon Root Flood-plain, occasional

98 Peltandra virginica (L) Kunth Mud-flat

99 Symplocarpus foetidus (L) Nutt Skunk Cabbage Flood-plain, occasional

JUNCACEAE (Rush Family)

100 Luzula saltuensis Fernald Climax forest, frequent

101 Luzula campestris (L) DC var multiflora (Ehrh) Celak Climax forest, frequent

LILIACEAE (Lily Family)

102 Uvularia grandiflora Sm Bellwort Climax forest, abundant, flood-plain

103 Allium tricoccum Ait Wild Leek Climax forest, frequent, flood-plain, occasional

104 Allium canadense L Wild Garlic Flood-plain, occasional

105 Lilium canadense L Wild Yellow Lily Flood-plain, occasional

106 Erythronium americanum Ker Yellow Adder's Tongue Climax forest, abundant, flood-plain, abundant

107. Smilacina racemosa (L) Desf False Spikenard Climax forest, abundant, flood-plain, abundant

108 SMILACINA STELLATA (L.) Desf. Flood-plain, abundant, mud-flat.

109 MAIANTHEMUM CANADENSE Desf. Climax forest, abundant.

110 POLYGONATUM BIFLORUM (Walt.) Ell. Small Solomon's Seal. Climax forest, abundant.

111 POLYGONATUM COMMUTATUM (R. & S.) Dietr. Great Solomon's Seal. Flood-plain, occasional.

112 MEDEOLA VIRGINIANA L. Indian Cucumber-root. Climax forest, occasional.

113 TRILLIUM RECURVATUM Beck. Climax forest, rare, flood-plain abundant.

114 TRILLIUM GRANDIFLORUM (Michx.) Salisb. Climax forest, frequent, flood-plain, occasional.

115 SMILAX HERBACEA L. Carrion-flower. Flood-plain, occasional.

116 SMILAX ECIRRHATA (Engelm.) Wats. Flood-plain, occasional.

117 SMILAX ROTUNDIFOLIA L. var. QUADRANGULARIS (Muhl.) Wood. Climax forest, forming part of the underbrush in sections, flood-plain, occasional.

118 SMILAX HISPIDA Muhl. Climax forest, frequent, flood-plain, frequent.

DIOSCOREACEAE (YAM FAMILY)

119 DIOSCOREA VILLOSA L. Wild Yam-root. Flood-plain, occasional.

IRIDACEAE (IRIS FAMILY)

120 IRIS VERSICOLOR L. Larger Blue Flag. Flood-plain, in buttonbush swamp.

PIPERACEAE (PEPPER FAMILY)

121 SAURURUS CERNUUS L. Lizard's Tail. Flood-plain, low place, abundant.

SALICACEAE (WILLOW FAMILY)

122 SALIX NIGRA MARSH Black Willow Flood-plain, trees overhanging river, frequent Mud-flat, seedling

123 SALIX CORDATA Muhl Mud-flat, seedling

124 POPULUS GRANDIDENTATA Michx Large-toothed Aspen Climax forest, fence row western edge of woods

125 POPULUS DELTOIDES Marsh Cotton-wood Flood-plain, mud-flat, seedling

JUGLANDACEAE (WALNUT FAMILY)

126 JUGLANS CINEREA L Butternut Flood-plain, large trees, frequent

127 CARYA OVATA (Mill) K Koch Shag-bark Hickory Climax forest, occasional

128 CARYA CORDIFORMIS (Wang) K Koch Bitter Nut Climax forest, occasional

BETULACEAE (BIRCH FAMILY)

129 CARPINUS CAROLINIANA Walt American Hornbeam Climax forest, occasional, flood-plain, frequent

FAGACEAE (BEECH FAMILY)

130 FAGUS GRANDIFOLIA Ehrh Beech Climax forest, one of the dominant trees, the seedlings and small trees forming dense underbrush in sections, also on flood-plain

131 QUERCUS ALBA L White Oak Climax forest, occasional

132 QUERCUS BICOLOR Willd Swamp White Oak Climax forest, occasional, flood-plain, frequent

133 QUERCUS MUHLENBERGII Engelm Yellow Oak, Chestnut Oak Flood-plain, frequent

134 QUERCUS RUBRA L Red Oak Climax forest, occasional, flood-plain, occasional

URTICACEAE (NETTLE FAMILY)

135 ULMUS FULVA Michx Slippery or Red Elm Flood-plain, occasional

136 ULMUS AMERICANA L American or White Elm Climax forest, occasional, flood-plain, occasional

137 CELTIS OCCIDENTALIS L Hackberry, Nettle-Tree, Sugar-berry Flood-plain, a few large trees at the south end of the woods

138 HUMULUS LUPULUS L Common Hop Flood-plain, mud-flat

139 MORUS RUBRA L Red Mulberry Flood-plain, only one medium sized tree noted

140 URTICA GRACILIS Ait Common Nettle Flood-plain, occasional

141 URTICA LYALLII Wats Flood-plain, frequent

142 LAPORTEA CANADENSIS (L) Gaud Wood Nettle Climax forest, frequent, flood-plain, abundant, mud-flat

143 PILEA PUMILA (L) Gray Clearweed Flood-plain, abundant, mud-flat

144 BOEHMERIA CYLINDRICA (L) Sw False Nettle Climax forest, frequent, flood-plain, frequent, mud-flat

ARISTOLOCHIACEAE (BIRTHWORT FAMILY)

145 ASARUM CANADENSE L Wild Ginger Climax forest, abundant, flood-plain, abundant

POLYGONACEAE (BUCKWHEAT FAMILY)

146 RUMEX VERTICILLATUS L Swamp Dock Flood-plain, frequent, mud-flat

147 RUMEX OBTUSIFOLIUS L Bitter Dock Flood-plain, frequent, mud-flat

148 POLYGONUM LAPATHIFOLIUM L Mud-flat

149 POLYGONUM AMPHIBIUM L var TERRESTRE Leers Mud-flat

150 POLYGONUM PENNSYLVANICUM L Mud-flat

151 Polygonum acre HBK var leptostachyum Meisn Mud-flat

152 Polygonum Persicaria L Lady's Thumb Mud-flat

153 Polygonum hydropiperoides Michx Flood-plain, low places, abundant

154 Polygonum hydropiperoides Michx var strigosum Small Flood-plain, less frequent than the type

155 Polygonum virginianum L Flood-plain, abundant, mud-flat

156 Polygonum convolvulus L Black Bindweed Flood-plain, occasional

157 Polygonum scandens L Climbing False Buckwheat Flood-plain, occasional

AMARANTHACEAE (Amaranth Family)

158 Amaranthus graecizans L Tumble Weed Flood-plain, occasional

159 Acnida tuberculata Moq Water Hemp Flood-plain, frequent along the banks of the Galien River, mud-flat

PHYTOLACCACEAE (Pokeweed Family)

160 Phytolacca decandra L Common Poke or Scoke-weed Climax forest, in openings where trees have been blown down and taken out and by the side of the wagon road, flood-plain, occasional

AIZOACEAE

161 Mollugo verticillata L Carpet Weed Flood-plain, occasional

CARYOPHYLLACEAE (Pink Family)

162 Stellaria longifolia Muhl Flood-plain, frequent

163 Stellaria media (L) Cyrill Common Chickweed Climax forest, frequent in wagon road, flood-plain, frequent, mud-flat

164 CERASTIUM VULGATUM L Common Mouse-ear Chickweed Climax forest, frequent in wagon road

PORTULACACEAE (PURSLANE FAMILY)

165 CLAYTONIA VIRGINICA L Spring Beauty Climax forest, abundant, flood-plain

166 CLAYTONIA CAROLINIANA Michx Climax forest, rare

RANUNCULACEAE (CROWFOOT FAMILY)

167 RANUNCULUS ABORTIVUS L Small-flowered Crowfoot Climax forest, in ravine and low places, mud-flat

168 RANUNCULUS RECURVATUS Poir Hooked Crowfoot Climax forest, frequent

169 RANUNCULUS SEPTENTRIONALIS Poir Swamp Buttercup Climax forest, frequent, low places, flood-plain, mud-flat

170 THALICTRUM DIOICUM L Early Meadow Rue Climax forest, frequent, flood-plain, frequent

171 HEPATICA ACUTILOBA DC Climax forest, abundant

172 CLEMATIS VIRGINIANA L Flood-plain, occasional

173 ISOPYRUM BITERNATUM (Raf) T & G Climax forest, abundant, flood-plain, abundant

174 AQUILEGIA CANADENSIS L Wild Columbine Climax forest, occasional, flood-plain, occasional

175 ACTAEA RUBRA (Ait) Willd Red Baneberry Climax forest, occasional

176 ACTAEA ALBA (L) Mill White Baneberry Climax forest, occasional, flood-plain

MAGNOLIACEAE (MAGNOLIA FAMILY)

177 LIRIODENDRON TULIPIFERA L White Wood Climax forest, occasional, flood-plain

ANONACEAE (CUSTARD APPLE FAMILY)

178 ASIMINA TRILOBA Dunal Common Papaw Climax forest, abundant, forming thick underbrush over large

portions of the woods, flood-plain, abundant, larger bushes than in the upland woods

MENISPERMACEAE (Moonseed Family)

179 Menispermum canadense L Flood-plain, occasional

BERBERIDACEAE (Barberry Family)

180 Podophyllum peltatum L Climax forest, abundant

181 Caulophyllum thalictroides (L) Michx Blue Cohosh Climax forest, frequent, flood-plain, occasional

LAURACEAE (Laurel Family)

182 Benzoin aestivale (L) Nees Spice Bush, Benjamin Bush Climax forest, frequent, flood-plain, abundant

PAPAVERACEAE (Poppy Family)

183 Sanguinaria canadensis L Climax forest, abundant, particularly on banks of ravines

FUMARIACEAE (Fumitory Family)

184 Dicentra Cucullaria (L) Bernh Dutchman's Breeches Climax forest, abundant

185 Dicentra canadensis (Goldie) Walp Squirrel Corn Climax forest, abundant, flood-plain, occasional

CRUCIFERAE (Mustard Family)

186 Radicula palustris (L) Moench Marsh Cress Mud-flat

187 Barbarea vulgaris R Br Common Winter Cress, Yellow Rocket Climax forest, low places, flood-plain, frequent, mud-flat

188 Dentaria laciniata Muhl Climax forest, frequent

189 Cardamine bulbosa (Schreb) BSP Spring Cress Flood-plain, low places, occasional

190 Cardamine Douglassii (Torr) Britton Climax forest, abundant in low places, flood-plain

191 ARABIS LAEVIGATA (Muhl) Poir Climax forest, occasional near border, flood-plain, occasional

CRASSULACEAE (ORPINE FAMILY)

192 PENTHORUM SEDOIDES L Mud-flat

SAXIFRAGACEAE (SAXIFRAGE FAMILY)

193 MITELLA DIPHYLLA L Climax forest, frequent

194 RIBES CYNOSBATI L Prickly Gooseberry Climax forest, frequent, flood-plain, frequent

195 RIBES CYNOSBATI L var GLABRATUM Fernald Climax forest, rare

HAMAMELIDACEAE (WITCH-HAZEL FAMILY)

196 HAMAMELIS VIRGINIANA L Witch-hazel Climax forest frequent

PLATANACEAE (PLANE TREE FAMILY)

197 PLATANUS OCCIDENTALIS L Sycamore Flood-plain, several very large trees

ROSACEAE (ROSE FAMILY)

198 PYRUS CORONARIA L American Crab Climax forest, occasional, flood-plain, frequent

199 PYRUS MALUS L Apple Climax forest, several small trees in fence row western border of woods

200 CRATAEGUS PUNCTATA Jacq Flood-plain, frequent

201 CRATAEGUS PUNCTATA Jacq var CANESCENS Britton Climax forest, only one tree in fence row on west side of woods

202 CRATAEGUS PEDICELLATA Sarg var ELLWANGERIANA (Sarg) Eggleston Flood-plain, one tree in fence row on public highway near the bridge A very beautiful tree when in full fruit

203 CRATAEGUS CHAPMANI (Beadle) Ashe var PLUKENETII Eggleston Flood-plain

204 GEUM CANADENSE Jacq Climax forest, occasional, flood-plain

205 GEUM VIRGINIANUM L Climax forest, occasional, flood-plain

206 RUBUS OCCIDENTALIS L Black Raspberry Climax forest, frequent, particularly near the wagon road

207 RUBUS FRONDOSUS Bigel Climax forest, side of wagon road

208 RUBUS PERGRATUS Blanchard Climax forest

209 RUBUS ELEGANTULUS Blanchard Climax forest, side of wagon road

210 RUBUS ANDREWSIANUS Blanchard Climax forest

211 RUBUS HISPIDUS L Flood-plain, low places

212 AGRIMONIA MOLLIS (T & G) Britton Flood-plain, occasional

213 PRUNUS SEROTINA Ehrh Climax forest, large trees occasional, flood-plain

LEGUMINOSAE (PULSE FAMILY)

214 CERCIS CANADENSIS L Redbud Flood-plain, occasional

215 DESMODIUM NUDIFLORUM (L) DC Climax forest, frequent

216 DESMODIUM GRANDIFLORUM (Walt) DC Climax forest, frequent

217 AMPHICARPA MONOICA (L) Ell Hog Peanut Climax forest, frequent

OXALIDACEAE (WOOD SORREL FAMILY)

218 OXALIS CORNICULATA L Lady's Sorrel Flood-plain, occasional, mud-flat

GERANIACEAE (GERANIUM FAMILY)

219 GERANIUM MACULATUM L Wild Cranesbill Climax forest, abundant, flood-plain

RUTACEAE (Rue Family)

220 Ptelea trifoliata L Flood-plain, occasional

EUPHORBIACEAE (Spurge Family)

221 Acalypha virginica L Flood-plain, occasional

LIMNANTHACEAE (False Mermaid Family)

222 Floerkea proserpinacoides Willd Climax forest, occasional, flood-plain

ANACARDIACEAE (Cashew Family)

223 Rhus typhina L Staghorn Sumach Climax forest, fence row

224 Rhus Toxicodendron L Poison Ivy, Poison Oak Climax forest, abundant, flood-plain, abundant

CELASTRACEAE (Staff Tree Family)

225 Evonymus obovatus Nutt Climax forest, abundant, flood-plain

226 Celastrus scandens L Climbing Bittersweet Flood-plain, occasional

STAPHYLEACEAE (Bladder Nut Family)

227 Staphylea trifolia L American Bladder Nut Flood-plain, forming underbrush in places

ACERACEAE (Maple Family)

228 Acer saccharum Marsh Sugar or Rock Maple Climax forest, the dominant tree, flood-plain

229 Acer saccharum Marsh var nigrum (Michx f) Britton Black Sugar Maple Flood-plain, occasional

230 Acer saccharinum L White or Silver Maple Climax forest, flood-plain, mud-flat, small seedling

231 ACER RUBRUM L Red or Swamp Maple Climax forest, occasional, flood-plain

BALSAMINACEAE (TOUCH-ME-NOT FAMILY)

232 IMPATIENS PALLIDA Nutt Pale Touch-me-not Climax forest, dense growth in low places, flood-plain

233 IMPATIENS BIFLORA Walt Spotted Touch-me-not Climax forest, abundant, mud-flat

VITACEAE (VINE FAMILY)

234 PSEDERA QUINQUEFOLIA (L) Greene Climax forest, abundant, flood-plain, abundant

235 VITIS VULPINA L River-bank or Frost Grape Climax forest, occasional, flood-plain, frequent, climbing on trees near bank of Galien River

TILIACEAE (LINDEN FAMILY)

236 TILIA AMERICANA L Basswood Climax forest, occasional, flood-plain

VIOLACEAE (VIOLET FAMILY)

237 VIOLA PAPILIONACEA Pursh Climax forest, near western border, frequent

238 VIOLA SORORIA Willd Climax forest, frequent

239 VIOLA BLANDA Willd Sweet White Violet Climax forest, low places

240 VIOLA SCABRIUSCULA Schwein Smooth Yellow Violet Climax forest, abundant, flood-plain, abundant

241 VIOLA CANADENSIS L Canada Violet Climax forest, abundant

242 VIOLA STRIATA Ait Climax forest, abundant, flood-plain, abundant, mud-flat

243 VIOLA CONSPERSA Reichenb Flood-plain, occasional

244 VIOLA ROSTRATA Pursh Long-spurred Violet Climax forest, occasional.

THYMELAEACEAE (Mezereum Family)

245 Dirca palustris L Leatherwood Climax forest, rare

ONAGRACEAE (Evening Primrose Family)

246 Ludvigia palustris (L) Ell Water Purslane Flood-plain, in low muddy places, mud-flat
247 Epilobium coloratum Muhl Climax forest, low places, frequent
248 Circaea lutetiana L Enchanter's Nightshade Climax forest, frequent
249 Circaea alpina L Climax forest, on rotting logs in low places

ARALIACEAE (Ginseng Family)

250 Aralia nudicaulis L Wild Sarsaparilla Climax forest, frequent
251 Panax trifolium L Dwarf Ginseng, Ground Nut Climax forest, occasional

UMBELLIFERAE (Parsley Family)

252 Sanicula marilandica L Flood-plain, occasional
253 Sanicula gregaria Bicknell Flood-plain, abundant
254 Sanicula trifoliata Bicknell Climax forest, occasional
255 Erigenia bulbosa (Michx) Nutt Harbinger-of-Spring Climax forest, rare
256 Chaerophyllum procumbens (L) Crantz Climax forest, densely matted in small areas, flood-plain, occasional
257 Osmorhiza Claytoni (Michx) Clarke Climax forest, abundant, flood-plain, abundant
258 Osmorhiza longistylis (Torr) DC Flood-plain, abundant
259 Cicuta maculata L Spotted Cowbane Flood-plain, low places, frequent, mud-flat

260 CRYPTOTAENIA CANADENSIS (L) DC Honewort Flood-plain, abundant

261 ZIZIA AUREA (L) Koch Golden Alexanders Flood-plain, occasional

262 HERACLEUM LANATUM Michx Cow Parsnip Flood-plain, abundant

CORNACEAE (DOGWOOD FAMILY)

263 CORNUS FLORIDA L Flowering Dogwood Climax forest, abundant, small plants in places forming underbrush, flood-plain

264 CORNUS ALTERNIFOLIA L f Climax forest, abundant, also forming underbrush, flood-plain

265 NYSSA SYLVATICA Marsh Black Gum, Pepperidge, Tupelo, Sour Gum Climax forest, one large tree near southern end of woods

ERICACEAE (HEATH FAMILY)

266 PYROLA ELLIPTICA Nutt Shin Leaf Climax forest, frequent

267 MONOTROPA UNIFLORA L Indian Pipe, Corpse Plant Climax forest, abundant

PRIMULACEAE (PRIMROSE FAMILY)

268 SAMOLUS FLORIBUNDUS HBK Water Pimpernel, Brookweed Mud-flat

269 STEIRONEMA CILIATUM (L) Raf Flood-plain, low places, frequent

OLEACEAE (OLIVE FAMILY)

270 FRAXINUS AMERICANA L White Ash Climax forest, occasional, flood-plain, mud-flat, small seedling

271 FRAXINUS PENNSYLVANICA Marsh Red Ash Flood-plain, occasional

272 FRAXINUS NIGRA Marsh Black Ash Climax forest, occasional, flood-plain

ASCLEPIADACEAE (Milkweed Family)

273 Asclepias incarnata L Swamp Milkweed Flood-plain, occasional, mud-flat

CONVOLVULACEAE (Convolvulus Family)

274 Cuscuta Cephalanthii Engelm Flood-plain, occasional

POLEMONIACEAE (Polemonium Family)

275 Phlox divaricata L Blue Phlox Climax forest, abundant, flood-plain, mud-flat

HYDROPHYLLACEAE (Waterleaf Family)

276 Hydrophyllum virginianum L Climax forest, abundant, flood-plain

277 Hydrophyllum canadense L Climax forest, rare

BORAGINACEAE (Borage Family)

278 Lappula virginiana (L) Greene Beggar's Lice Climax forest, occasional

VERBENACEAE (Vervain Family)

279 Verbena urticaefolia L White Vervain Flood-plain, occasional, mud-flat

280 Lippia lanceolata Michx Fog-fruit Mud-flat

LABIATAE (Mint Family)

281 Teucrium canadense L American Germander, Wood Sage Flood-plain, occasional, mud-flat

282 Teucrium occidentale Gray var boreale (Bicknell) Fernald Flood-plain, rare

283 Scutellaria lateriflora L Mad-dog Skullcap Climax forest, low places, flood-plain, frequent, mud-flat

284 Prunella vulgaris L Heal-all, Carpenter-weed Flood-plain, frequent, mud-flat

285 STACHYS TENUIFOLIA Willd Climax forest, low places, flood-plain, mud-flat

286 MONARDA FISTULOSA L Wild Bergamont Flood-plain, occasional

287 BLEPHILIA HIRSUTA (Pursh) Benth Wood Mint Flood-plain, frequent, mud-flat

288 LYCOPUS RUBELLUS Moench Flood-plain, frequent

289 LYCOPUS AMERICANUS Muhl Mud-flat

290 MENTHA ARVENSIS L var CANADENSIS (L) Briquet Flood-plain, occasional, mud-flat

SOLANACEAE (NIGHTSHADE FAMILY)

291 SOLANUM NIGRUM L Common Nightshade Climax forest, occasional, mud-flat

292 SOLANUM CAROLINENSE L Horse Nettle Flood-plain, occasional

SCROPHULARIACEAE (FIGWORT FAMILY)

293 SCROPHULARIA MARILANDICA L Flood-plain, occasional

294 SCROPHULARIA LEPORELLA Bicknell Flood-plain, occasional

295 CHELONE GLABRA L Turtlehead, Snakehead Flood-plain, occasional

296 MIMULUS RINGENS L Monkey Flower Flood-plain, occasional, mud-flat

297 ILYSANTHES DUBIA (L) Barnhart Flood-plain, rare

298 VERONICA SERPYLLIFOLIA L Thyme-leaved Speedwell Climax forest, in wagon road

299 VERONICA ARVENSIS L Corn Speedwell Climax forest, in wagon road

OROBANCHACEAE (BROOM-RAPE FAMILY)

300 EPIFAGUS VIRGINIANA (L) Bart Beech-drops Climax forest, abundant, flood-plain

PLANTAGINACEAE (PLANTAIN FAMILY)

301 PLANTAGO RUGELII Dcne Climax forest, in wagon road, mud-flat

RUBIACEAE (Madder Family)

302 Galium Aparine L Cleavers, Goose Grass Climax forest, abundant, food-plain, abundant, mud-flat

303 Galium circaezans Michx Wild Liquorice Climax forest, frequent

304 Galium lanceolatum Torr Climax forest, frequent

305 Galium tinctorium L Flood-plain, occasional

306 Galium concinnum T & G Climax forest, frequent, flood-plain, frequent

307 Galium triflorum Michx Sweet-scented Bedstraw Climax forest, frequent, flood-plain

308 Mitchella repens L Partridge Berry Climax forest, frequent

309 Cephalanthus occidentalis L Buttonbush Flood-plain, abundant, forming buttonbush swamps, mud-flat, seedlings

CAPRIFOLIACEAE (Honeysuckle Family)

310 Lonicera canadensis Marsh American Fly Honeysuckle Climax forest, occasional

311 Lonicera glaucescens Rydb Climax forest, rare

312 Viburnum acerifolium L Maple-leaved Viburnum Climax forest, abundant

313 Sambucus racemosa L Red-berried Elder Climax forest, occasional

VALERIANACEAE (Valerian Family)

314 Valerianella chenopodifolia (Pursh) DC Flood-plain, low places, rare

CUCURBITACEAE (Gourd Family)

315 Echinocystis lobata (Michx) T & G Wild Balsam-apple Flood-plain, occasional, mud-flat

CAMPANULACEAE (Bluebell Family)

316 Campanula americana L Tall Bellflower Climax forest, occasional near border, flood-plain, frequent

LOBELIACEAE (Lobelia Family)

317 Lobelia Cardinalis L Cardinal Flower Flood-plain, occasional

318 Lobelia siphilitica L Great Lobelia Mud-flat

COMPOSITAE (Composite Family)

319 Vernonia missurica Raf Mud-flat

320 Eupatorium purpureum L Joe-Pye Weed Flood-plain, frequent

321 Eupatorium perfoliatum L Boneset, Thoroughwort Mud-flat

322 Eupatorium urticaefolium Reichard White Snakeroot Flood-plain, occasional, mud-flat

323 Solidago caesia L var axillaris (Pursh) Gray Climax forest, abundant

324 Solidago latifolia L Climax forest, occasional, flood-plain

325 Solidago rugosa Mill Climax forest, frequent

326 Solidago canadensis L Flood-plain, frequent

327 Solidago serotina Ait Mud-flat

328 Aster macrophyllus L Climax forest, abundant

329 Aster cordifolius L Climax forest, frequent, flood-plain

330 Aster lateriflorus (L) Britton Flood-plain, frequent, mud-flat

331 Aster lateriflorus (L) Britton var glomerellus (T & G) Burgess Climax forest, rare

332 Aster Tradescanti L Climax forest, frequent, flood-plain, mud-flat

333 Aster paniculatus Lane Mud-flat

334 Erigeron philadelphicus L Flood-plain, occasional

335 Erigeron annuus (L) Pers Daisy Fleabane Flood-plain, occasional

336 Erigeron canadensis L Horse-weed, Butter-weed Mud-flat

337 Gnaphalium polycephalum Michx Common Everlasting Climax forest, in clearings made by fallen trees and in wagon road

338 Silphium perfoliatum L Cup Plant Flood-plain, occasional

339 Ambrosia trifida L Great Ragweed Flood-plain, abundant, mud-flat

340 Ambrosia artemisiifolia L Roman Wormwood, Hog-weed, Bitter-weed, Ragweed Climax forest, in clearings made by uprooted trees, mud-flat

341 Xanthium canadense Mill Cocklebur Flood-plain, frequent

342 Xanthium commune Britton Mud-flat

343 Rudbeckia laciniata L Flood-plain, occasional, mud-flat

344 Helianthus decapetalus L Flood-plain, occasional

345 Bidens discoidea (T & G) Britton Climax forest, in low places, infrequent

346 Bidens frondosa L Beggar-ticks Mud-flat

347 Bidens comosa (Gray) Wiegand Mud-flat

348 Bidens cernua L Mud-flat

349 Achillea Millefolium L Common Yarrow, Milfoil Climax forest, in wagon road and clearings made by uprooted trees

350 Erechtites hieracifolia (L) Raf Climax forest, in clearings made by uprooted trees, flood-plain

351 Senecio aureus L Golden Ragwort Flood-plain, occasional

352 Arctium minus Bernh Common Burdock Climax forest, in clearings made by uprooted trees

353 Cirsium lanceolatum (L) Hill Common or Bull Thistle Climax forest, in clearings made by uprooted trees

354 Taraxacum officinale Weber Common Dandelion Climax forest, flood-plain, mud-flat

355 TARAXACUM ERYTHROSPERMUM Andrz Red-seeded Dandelion Flood-plain, occasional

356 LACTUCA SCARIOLA L Prickly Lettuce Climax forest, frequent

357 LACTUCA SPICATA (Lam) Hitchc Flood-plain, occasional

358 PRENANTHES ALBA L Rattlesnake-root Climax forest, occasional

DETROIT, MICHIGAN

EXPLANATION OF PLATES

PLATE IX

WARREN WOODS PRESERVE Climax beech-maple forest at left of picture and flood-plain at right The wagon road also is seen in this cut (Photograph by George R Fox)

PLATE X

WARREN WOODS PRESERVE Climax beech-maple forest, showing almost complete absence of undergrowth This condition prevails over large portions of the forest (Photograph by George R Fox)

PLATE XI

FIG 1 One of the mud-flats beside the Galien River in the Warren Woods Preserve, photographed in August, 1919 The vegetation is confined to the inner edge In 1921 the bar was entirely covered with vegetation and could scarcely be distinguished from the older portion of the flood-plain (*Photograph by Lee R Dice The cut is used by courtesy of* the Museum of Zoology, University of Michigan)

FIG 2 The Galien River in Warren Woods Preserve and the flood-plain forest (Photograph by George R Fox)

FIG 3 The climax beech-maple forest, Warren Woods Preserve, showing undergrowth of young beech and maple trees

PLATE IX

Warren Woods Preserve

PLATE X

Warren Woods Preserve

PLATE XI

FIG. 2

FIG. 3

WARREN WOODS PRESERVE

THE ABSENCE OF CHROMOSOME PAIRING DURING MEIOSIS IN *OENOTHERA BIENNIS* *

STERLING H EMERSON

In a recent paper by Cleland [1] there appears a preliminary account of the reduction division in *Oenothera biennis* He finds that as the chromosomes shorten and thicken in late heterotypic prophase they are arranged end to end in strings, as is common in Oenotheras, but in this species they generally form two closed rings, one of six chromosomes and the other with eight, with some minor variations While he noted that there was no parasynaptic pairing of chromosomes at a metaphase stage, he did believe that there was a mechanism insuring the separation of homologous chromosomes He observed that adjacent chromosomes became attached to spindle fibers from opposite poles, alternate ones becoming attached to fibers from the same pole Presumably homologous chromosomes lie adjacent and would thus always be separated

The studies reported in the present paper were begun in February, 1923, with material kindly supplied to me by Professor B M Davis Additional material has since been collected from plants grown by Professor Davis Second-contraction figures here showed chromosome arrangements very similar to the rings described by Cleland (Plate XII, Figs 1-6) The great discrepancy between my observations and those of Cleland is that I found no regular method of separation of homologous chromosomes Irregularities in chromosome separation were the outstanding features in my preparations

* Paper from the Department of Botany, University of Michigan, No 214

[1] Cleland, Ralph E *Chromosome Arrangements during Meiosis in Certain Oenotheras* Amer Nat, 57 562-566 1923

As the spindles are forming preparatory to the separation of the chromosomes, the ring formations noted in second contraction are still evident (Plate XII, Figs 8–12) In no case could it be seen that adjacent chromosomes uniformly became attached to fibers from opposite poles As the chromosomes separate in anaphase, adjacent chromosomes still attached can often be seen passing to the same pole, in some cases as many as six or seven attached chromosomes go to the same pole (Plate XIII and Plate XIV, Fig 1) Often the chromosomes become detached early and it is impossible to tell what position they had in the rings Chromosomes attached end to end can sometimes be seen in telophase as the daughter nuclei are passing into the interkinesis period (Plate XIV, Figs 2–7) These chromosome arrangements do not permit a regular method of chromosome separation such as described by Cleland

Oenothera biennis mut *sulfurea* is a mutation from *Oe biennis*, differing from it only in its lighter flower color This form shows the same chromosomal behavior during meiosis as did its parent form and figures of it are included in the accompanying illustrations as noted in the explanation of plates

It has been shown by De Vries [2] that the sulfur-flower character in *Oe biennis* and mut *sulfurea* is patroclinic in its inheritance, with the first generation resembling the male parent and breeding true in succeeding generations The same sulfur-flower character was introduced into another species when Davis [3] crossed *Oe biennis* with *Oe franciscana* This character in *Oe franciscana* and the sulfur-flowered form resembling it behaved as a Mendelian recessive (manuscript data of Professor Davis) Cleland has shown that in *Oe franciscana* [4] there is a normal pairing of homologous chromosomes, while in *Oe franciscana sulfurea* [5] there is normal pairing of two chromosomes, the other

[2] De Vries, Hugo *Gruppenweise Artbildung*, pp 297–298 Gebr Borntraeger Berlin 1913

[3] Davis, Bradley Moore *Hybrids of Oenothera biennis and Oenothera franciscana in the First and Second Generations* *Genetics*, 1 197–251 1916

[4] Cleland, Ralph E *The Reduction Division in the Pollen Mother Cells of Oenothera franciscana.* *Amer Journ Bot*, 9 391–413 1922

[5] Cleland, Ralph E *Meiosis in Pollen Mother Cells of Oenothera franciscana sulfurea* *Bot. Gaz*, 77 149–170 1924

twelve behave as in *Oe biennis* This is the only case known in which a character shows patroclinic inheritance (non-Mendelian) in one species and when introduced into another species shows Mendelian behavior Cytological studies show that in the former case there is no regular segregation of chromosomes such as is necessary for Mendelian inheritance, while in the latter case there is such a segregation

It is possible that where there is no pairing of chromosomes there are no homologous chromosomes *Oe biennis* on this assumption would have fourteen different chromosomes in place of seven pairs of homologous chromosomes The cytological and genetical results reviewed above are in harmony with such a view

University of Michigan

EXPLANATION OF PLATES

PLATE XII

FIG 1 *Oe biennis* — prophase, ring of six chromosomes and strings of six and two chromosomes

FIG 2 *Oe biennis* — prophase, incomplete section showing ring of six and string of six chromosomes

FIGS 3–4 *Oe biennis* — prophase, incomplete sections

FIG 5 Mut *sulfurea* — prophase, ring of six and strings of six and two chromosomes

FIG 6 Mut *sulfurea* — prophase, rings of six and eight chromosomes

FIGS 7–9 *Oe biennis* — spindle formation preceding "metaphase"

FIGS 10–11 Mut *sulfurea* — spindle formation preceding "metaphase"

FIGS 12–13 *Oe biennis* — "metaphase"

PLATE XIII

FIGS 1, 2, 4, 6, 7, 8 *Oe biennis* — separation of chromosomes in anaphase

FIGS 3, 5 Mut *sulfurea* — separation of chromosomes

PLATE XIV

FIG 1 Mut *sulfurea* — polar view of late anaphase with diagrams of the chromosome groups at either pole, *a* = upper and *b* = lower group of chromosomes

FIGS 2, 5 *Oe Biennis* — chromosómes at one pole in late anaphase

FIG 3 *Oe biennis* — polar view of early telophase, *c* = upper and *d* = lower group of chromosomes (on the slide one lies directly over the other)

FIGS 4, 6 *Oe biennis* — chromosomes grouped at poles in early telophase

FIG 7 Mut *sulfurea* — late telophase, six of the chromosomes are strongly attached in a string

PLATE XII

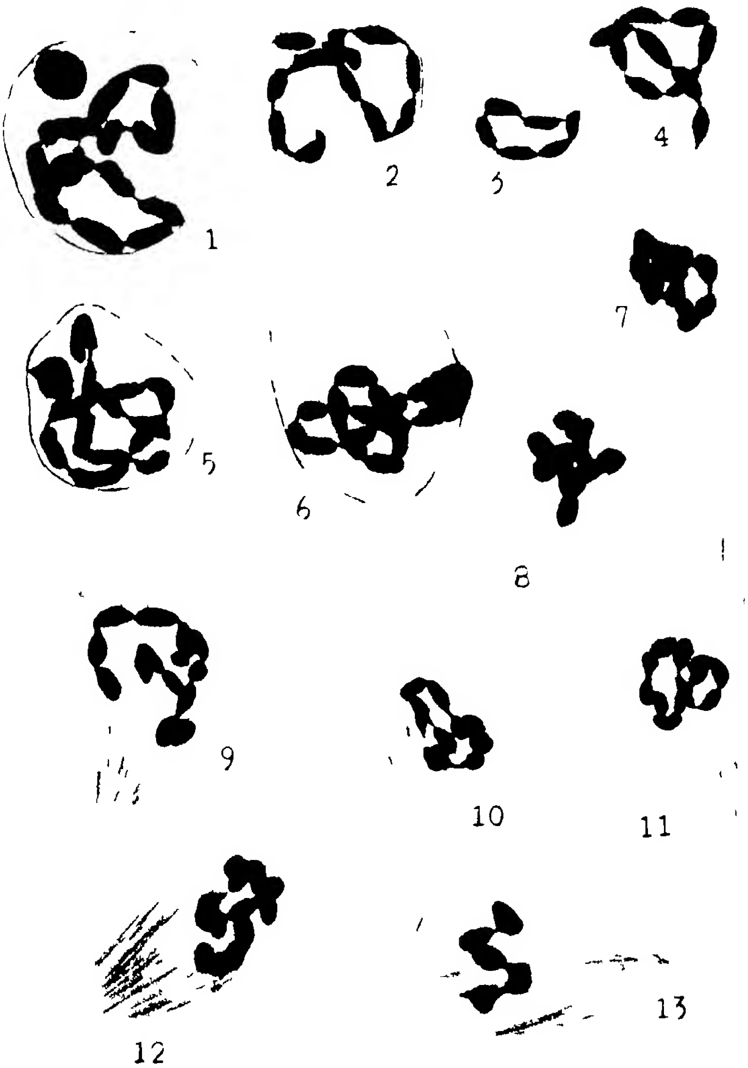


PLATE XIII

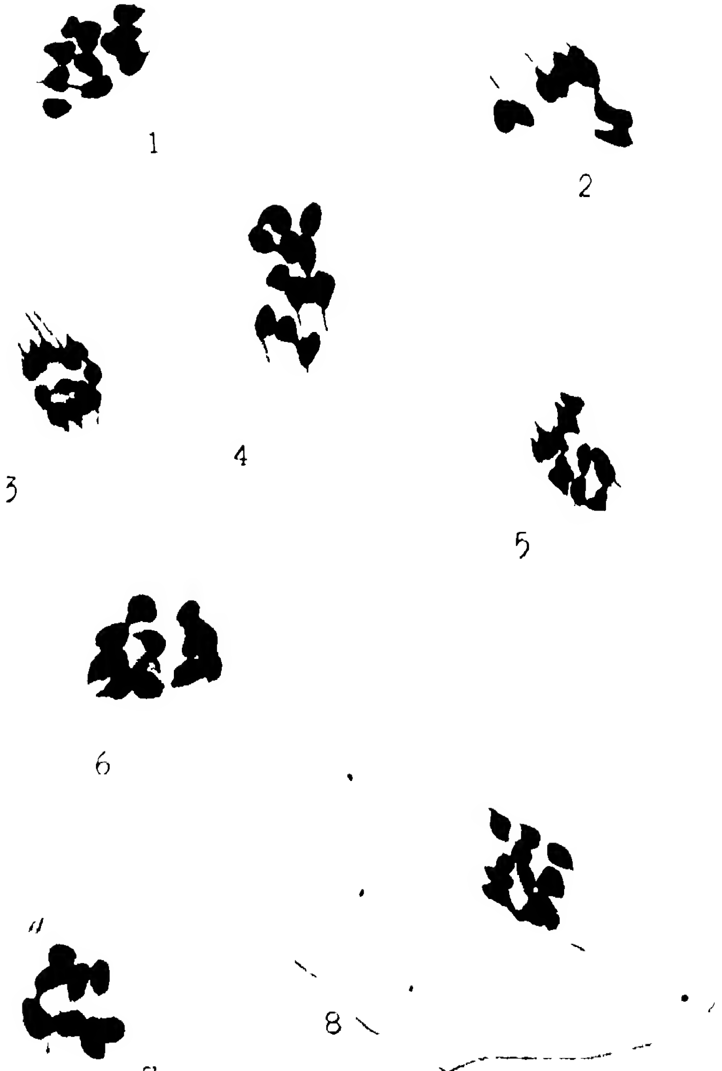


PLATE XIV

THE FLORA OF THE PENINSULA OF VIRGINIA *

EILEEN WHITEHEAD ERLANSON

THE Peninsula of Virginia, which lies southeast of Richmond, is about sixty miles long by fifteen miles wide It is bounded on the east by Chesapeake Bay, on the northeast by the York River estuary, and on the southwest by the James River, it is all within the coastal plain

The old town of Williamsburg is situated thirty miles from the coast, on the divide between the two rivers Although the highest point is only about one hundred feet above sea-level, the whole Peninsula is far from dull or uniform in surface

The geological formations are Recent and Quaternary in the east and pass into Miocene in the western part The soils are sandy with intermixtures of clay and shell marls

The York River shore is a typical maritime coast, with salt marshes and small sand-dunes The water of the James River estuary is fresh, or slightly brackish, and its many tributaries flow through extensive cypress swamps, the most noteworthy being those of the Chickahominy and Powhatan rivers The area of uncultivated land is possibly as large as in any section of the east, exclusive of the mountainous regions

In several respects the local flora is particularly interesting The many typical pine-barren areas of the region contrast markedly with the conditions in the humid cypress swamps close by Because of the diversified habitats the plants are in many cases very locally distributed, even *Claytonia virginica* grows in only a few, widely separated, flood-plains Strange as it may seem, both Betula and Crataegus are extremely rare in the region The only representatives of these genera which were found were

* Paper from the Department of Botany of the University of Michigan, No 209

two separate trees of *Betula nigra*, near Williamsburg, a few scattered individuals of *Crataegus Crus-galli*, and a clump of one other native species of hawthorn

On the other hand *Monotropsis odorata*, which is generally considered as "rare," is frequent throughout the Peninsula in dry oak woods, it flowers in February and March A few species more typical of the Alleghanian region are also to be found here, these are *Stewartia pentagyna*, *Parnassia asarifolia* and *Rudbeckia laciniata* var *humilis* During the Great War several European plants were introduced, it is thought, and have become established around Newport News and Norfolk The only European species we found that had not previously been reported in North America was *Ajuga chamaepitys*, which was well established on the south shore of the York River, about a dozen miles above Yorktown

The plants of the following list were collected by Earl Jerome Grimes and the writer, during the spring and autumn of 1920, and throughout 1921 The College of William and Mary, at Williamsburg, was our base, and the country in the immediate vicinity was thoroughly worked over for a radius of ten miles Collecting trips were also made along the railway at various points between Newport News and Elko, Henrico County

It is well known that Banister, Clayton and Mitchell made extensive botanical explorations in eastern Virginia in the eighteenth century, very little indeed has been done since in the State, except by visiting botanists To this lack of local botanical interest are attributed the many rare "finds" which were made in this small area in two seasons [1]

The most noteworthy plants of northern range discovered were *Pogonia affinis* Aust, one of the rarest orchids of New England and Pennsylvania, *Juncus asper* Engelm, hitherto supposed to be confined to the pine-barrens of New Jersey, and *Polygonum densiflorum* Meisn, previously known from southern New Jersey and Delaware Several plants belonging to the southern coastal plain, which had been reported from North Caro-

[1] An account of the most interesting plants found was published in *Rhodora*, 24 148, 25 17

lina, were found The most notable extension of range was made by the discovery of *Habenaria repens* Nutt, not previously reported north of Florida, growing beside the Chickahominy River near Lanexa *Uniola longifolia* Scribn, heretofore known from Georgia and Tennessee, was found near Williamsburg Of foremost interest is the apparent re-discovery of Clayton's "Chelone floribus speciosis pulcherrimis colore rosae damascenae," with sessile leaves This plant has been named *Chelone Grimesii* by Mr Weatherby

A study of the flora of eastern Virginia not only helps to fill gaps in our knowledge of plant distribution, but also throws light on the type forms of many American species described by Gronovius and other early botanists, because a great many of their specimens came from this region The correct interpretation of Linnaean species often depends upon an accurate knowledge of the flora of the region where Clayton worked It is hoped that the present list will be of value, although it is not by any means a complete flora

Duplicates of almost all the collections were sent to the Gray Herbarium Thanks are due to Mr C A Weatherby, Mrs Agnes Chase, Dr Ezra Brainerd, and other botanists, for kindly furnishing determinations After Mr Grimes' death in December, 1921, his herbarium was purchased for the Herbarium of the New York Botanical Gardens

The list is arranged according to Gray's *Manual* (7th ed), and the collection numbers of Grimes are given While we were doing this work, an attempt was made to collect the most important references to the flora of Virginia, these are appended in the bibliography

The stations for a thousand and fifty-two species and varieties are given Those plants which are included in articles published in *Rhodora* are marked with an asterisk

Adiantum pedatum L Near Williamsburg Oct 17, 1920 3167

Aspidium noveboracense (L) Sw Rich moist hardwoods, throughout the Peninsula 3735

ASPIDIUM SPINULOSUM (O F Muller) Sw White oak woods, near Williamsburg June, 1921 2712

ASPIDIUM THELYPTERIS (L) Sw Swamps along James River, near Camp Wallace July, 1921

ASPLENIUM FILIX-FEMINA (L) Bernh Rich moist woods 3765, 4098

ASPLENIUM PLATYNEURON (L) Oakes Dry woods, near Williamsburg 1920 3156, 4148

ASPLENIUM PLATYNEURON (L) Oakes var SERRATUM (E S Miller) B S P Dry ravine, west of Williamsburg Oct, 1920 3157

ATHYRIUM ASPLENIOIDES (Michx) Desv Moist ravine, west of Williamsburg Oct 19, 1920 3184

DENNSTAEDTIA PUNCTILOBULA (Michx) Moore Rich wooded banks, west of Williamsburg 3165, 3884

ONOCLEA SENSIBILIS L Moist flood-plains Common 4575

POLYPODIUM POLYPODIOIDES (L) Hitchc On trunk of Platanus, flood-plain of Queen's Creek, north of Williamsburg March 13, 1921 3275

POLYSTICHUM ACROSTICHOIDES (Michx) Schott Open woods, James City Co Oct, 1920 3161

POLYSTICHUM ACROSTICHOIDES Schott var INCISUM (Gray) Gilbert Openings in mixed woods, west of Williamsburg Oct, 1920 3162

PTERIS AQUILINA L Sandy heath near Ewell

THELYPTERIS HEXAGONOPTERA (Michx) Weatherby Rich hardwoods Common 3957, 3117, 3163

THELYPTERIS NOVEBORACENSIS (L) Nieuwl Dry ravines and pine woods Common Oct, 1920 3164, 3222

THELYPTERIS PALUSTRIS Schott Open swamps at Longhill, James City Co July, 1921 4097

WOODWARDIA AREOLATA (L) Moore Wet wooded ravines near Williamsburg Common 3193

WOODWARDIA VIRGINICA (L) Sm Sphagnum bogs, James City Co June and July, 1921 3855, 3914

OSMUNDA CINNAMOMEA L Moist soil in pine woods, James City Co May 4, 1921 2554

OSMUNDA CLAYTONIANA L Moist oak woods, James City Co June 6, 1921 3646

OSMUNDA REGALIS L Rich hardwoods, west of Williamsburg May 17, 1921 3571

BOTRYCHIUM OBLIQUUM Muhl Young pine woods near Williamsburg Oct 1, 1920 3113

BOTRYCHIUM OBLIQUUM var DISSECTUM (Spreng) Clute Flood-plain of Chisel's Run, west of Williamsburg Aug 25, 1921 4307, 4436

BOTRYCHIUM VIRGINIANUM (L) Sw Flood-plains of streams flowing north into Queen's Creek, York Co April, 1921 3403, 3443

OPHIOGLOSSUM VULGATUM L Rich soil of mixed woods north of Williamsburg April 17, 1921 3445

EQUISETUM ARVENSE L Sandy soil near Williamsburg March 28, 1921 3368

EQUISETUM HYEMALE L var AFFINE (Engelm) A A Eaton Near Williamsburg April, 1921 3383

LYCOPODIUM ADPRESSUM Lloyd & Underw Sandy soil in damp ditch in flat pine woods, C & O Railroad cut northwest of Williamsburg July 1, 1921 3908 Henrico Co near Elko 4199

LYCOPODIUM LUCIDULUM Michx Pine woods near Williamsburg July 19, 1921 4062

LYCOPODIUM OBSCURUM L Wet soil of flood-plain hardwoods, Chisel's Run, west of Williamsburg March 22, 1921 3305

SELAGINELLA RUPESTRIS (L) Spring Abundant in low moist places

JUNIPERUS VIRGINIANA L Field north of Williamsburg March 17, 1921 3299 Common

PINUS ECHINATA Mill Edge of flat woods near Williamsburg Dec , 1920 3248, 3261 Occasional

? PINUS RIGIDA Mill Dry sandy embankment along railroad west of Williamsburg Large tree April, 1921 3481

PINUS TAEDA L Flat woods, sandy soil near Williamsburg Dec , 1920 3262, 3263, 3251

PINUS VIRGINIANA Mill Common in sandy soil throughout the Peninsula, invading abandoned fields in second year Dec , 1920 3249, 3250, 3259, 3260, 3265

TAXODIUM DISTICHUM (L) Richard Chickahominy River at Lanexa, July 30, 1921 Shore of James River south of Williamsburg Aug 15, 1921 4142, 4249

TYPHA ANGUSTIFOLIA L Open swamp near Williamsburg July 11, 1921 3680

TYPHA LATIFOLIA L Near Williamsburg June 23, 1921 3811

SPARGANIUM AMERICANUM Nutt Mouth of Chisel's Run at Longhill Swamp, James City Co July 23, 1921 In a stream between Elko and Poplar Springs, Aug 6, 1921 4084, 4208

NAIAS GUADALUPENSIS (Spreng) Morong In Jones' Mill Pond, Williamsburg Dec 12, 1920

POTOMOGETON CRISPUS L In Jones' Mill Pond, Williamsburg Dec , 1920 3255

POTOMOGETON PULCHER Tuckerm In a pond near Elko, Henrico Co , Aug 6, 1921 4196

ZANNICHELLIA PALUSTRIS L var MAJOR (Boeningh) K Koch Running water, Queen's Creek, York Co , April 17, 1921 3452

ALISMA SUBCORDATUM Raf Wooded swamp along Chickahominy River at Lanexa July 30, 1921 4127

ECHINODORUS TENELLUS (Mart) Buchenau (submersed form) Edge of water, Chickahominy River at Lanexa July 30, 1921 4135

SAGITTARIA FALCATA Pursh Tidal marsh along Queen's Creek, north of Williamsburg June 28, 1921 3864

SAGITTARIA PUBESCENS Muhl Sphagnum swamp, Longhill, James City Co , July 23, 1921 4083

SAGITTARIA SUBULATA (L) Buchenau Tidal swamp along Chickahominy River near Lanexa July 30, 1921 4129

ELODEA CANADENSIS Michx Introduced into Jones' Mill Pond, Williamsburg 1920, established in creek, quarter of a mile below, in 1921

AGROSTIS HYEMALIS (Walt) B S P Dry soil along railway,

Williamsburg, May 29, 1920 Sandy roadside north of town, June 12, 1921 2620, 3694

AGROSTIS PALUSTRIS Huds Meadows and open ground, York Co June and July, 1921 3660, 3726, 3953, 3955

AGROSTIS PERENNANS (Walt) Tuckm Roadside, west of Williamsburg, June, 1921 3838, 4350

AIRA CAPILLARIS Host Edge of flat pine woods, Williamsburg May 23, 1921 3626

AIRA PRAECOX L Campus of College, Williamsburg May 18, 1921 3584

ALOPECURUS AGRESTIS L Cultivated field west of Williamsburg May 1, 1921 3508

ANDROPOGON FURCATUS Muhl Dry field, near Williamsburg, Sept , 1921 4383

ANDROPOGON GLOMERATUS (Walt) B S P Thin pine woods, north shore of Queen's Creek, north of Williamsburg, June 28, 1921 3874

ANDROPOGON SCOPARIUS Michx Thin pine woods, sandy soil, west and north of Williamsburg Sept , 1920, June and July, 1921 3085, 3869, 4077

ANDROPOGON VIRGINICUS L Dry clayey field, Williamsburg Oct 17, 1920 3171

ANHTOXANTHUM ODORATUM L Roadside and clearing in deep woods, near Williamsburg May, 1920 2547, 2606

ARISTIDA DICHOTOMA Michx Edge of flat pine woods, near Williamsburg Sept 25, 1920 3092

ARISTIDA GRACILIS Ell Dry soil of roadside, north of Williamsburg Oct 8, 1921 4566

ARISTIDA OLIGANTHA Michx Bright Farm, Williamsburg, clay soil Oct 8, 1920 3127

ARISTIDA PURPURASCENS Poir Sandy soil of oak slope, near Williamsburg Nov 5, 1920 3239

ARRHENATHERUM ELATIUS (L) Beauv Wooded flood-plains, Queen's Creek, York Co May 23, 1921 3622

ARUNDINARIA MACROSPERMA Michx Small cypress swamp, south of Five Forks, James City Co March 26, 1921 3348

AVENA SATIVA L Common around Williamsburg

BRACHYELYTRUM ERECTUM (Schreb) Beauv Deep shaded ravine in hardwood, southeast of Williamsburg July 19, 1921 4055

BROMUS COMMUTATUS Schrad Near Williamsburg June 10, 1921 3658, 3835

BROMUS PURGANS L Deep ravine, along James River, at Camp Wallace July 5, 1921 3936

BROMUS SECALINUS L Old track in woods, Williamsburg June, 1921 3885

CALAMAGROSTIS CINNOIDES (Muhl) Barton Sphagnum-magnolia swamps, James City Co , Aug , 1921, Oct , 1920, 1921 4317, 3194, 4620

CENCHRUS PAUCIFLORUS Benth Clay bank along railway, Lightfoot, James City Co , July 23, 1921 Sandy shore of York River, Oct , 1921 4089, 4567

CINNA ARUNDINACEA L Tidal marshes and wooded flood-plain of James River, Aug , 1921 Tidal marshes of Queen's Creek, York Co , Aug , 1921 4241, 4302

CYNODON DACTYLON (L) Pers Ballast along railway, near Williamsburg June 17, 1921 3735

DACTYLIS GLOMERATA L Common, around Williamsburg

DANTHONIA SERICEA Nutt Edges of dry sandy pine woods Common near Williamsburg May 23, 1921 3625

DANTHONIA SPICATA (L) Beauv Clay slope, north end of Jones' Mill Pond, Williamsburg May 29, 1920 2628

DIGITARIA FILIFORMIS (L) Koeler , Dry roadside, Williamsburg Sept 17, 1921 4396

DIGITARIA HUMIFUSA Pers Dry roadside, Williamsburg Sept , 1921 4396a

DIGITARIA SANGUINALIS (L) Scop Corn-field, Williamsburg, Oct , 1920 Along railway, east of Diascund, July, 1921 3235, 4166

DISTICHLIS SPICATA (L) Greene Tidal salt marshes, south shore of York River Constitutes the bulk of "salt hay" Aug , 1921 4282

ECHINOCHLOA CRUSGALLI (L) Beauv Sandy roadside, south of Williamsburg, July, 1921 3964

ECHINOCHLOA WALTERI (Pursh) Nash Moist ground along Chickahominy River, at Lanexa, July, 1921 Moist ground, near Williamsburg, Sept, 1921 4131, 4404

ELEUSINE INDICA Gaertn Cultivated ground, Williamsburg Nov, 1920 3240

ELYMUS CANADENSIS L Low ground along Centerville-Williamsburg road, June 22, 1921

ELYMUS STRIATUS Willd Wooded ravine beside James River, at Camp Wallace July 5, 1921 3934

ELYMUS VIRGINICUS L Edge of tidal marshes, and moist roadsides James City and York counties July 1921 3808, 3967

ERAGROSTIS CAROLINIANA (Spr) Scribn Railway bank, at Williamsburg, July 22, 1921 4071

ERAGROSTIS CILIANENSIS (All) Link Cultivated ground, Williamsburg July 31, 1921 4178

ERAGROSTIS HIRSUTA (Michx) Nees Dry soil, along railway, west of Lightfoot, James City Co, Sept 27, 1921 4494

ERAGROSTIS HYPNOIDES (Lam) B S P Mud-flat, Jones' Mill Pond, Williamsburg Sept, 1921 4407

ERAGROSTIS MEGASTACHYA (Koeler) Link Cultivated land, Williamsburg

ERAGROSTIS PECTINACEA (Michx) Steud Dry soil, west of Williamsburg Along railway, near Lanexa July, 1921 4051, 4169

ERIANTHUS SACCHAROIDES Michx Sphagnum-magnolia swamp, southeast of Ewell Sept 27, 1921 4473

FESTUCA ELATIOR L Roadsides and fields around Williamsburg

FESTUCA MYURUS L In sand, near York River, north of Williamsburg, June 6, 1920 2656

FESTUCA OBTUSA Spreng Rich woods and flood-plains, around Williamsburg May, 1921 3602, 3618

FESTUCA OCTOFLORA Walt Weed, in waste sandy soil, around Williamsburg May, 1921 2622, 3590

GLYCERIA GRANDIS Wats Moist sandy soil, south of Williamsburg June 23, 1921 3813

GLYCERIA NERVATA (Willd) Trin Shaded and open swamps, around Williamsburg June, 1920, May, 1921 2686, 3611

GLYCERIA OBTUSA (Muhl) Trin Swampy woods, Poplar Springs, Henrico Co, Aug 6, 1921 4213

GYMNOPOGON AMBIGUUS (Michx) B S P Second-growth pine thicket, west of Williamsburg Rare Nov 5, 1920 3238

HOLCUS HALEPENSIS L Roadside, near Williamsburg July 5, 1921 3927

HOLCUS LANATUS L Meadow, near Williamsburg May 2, 1921 3532

HORDEUM PUSILLUM Nutt Cultivated fields, Williamsburg June, 1920 2676

HYSTRIX PATULA Moench Rich moist hardwoods, north of Williamsburg June, 1921 3754

LEERSIA ORYZOIDES (L) Sw Open swampy flood-plains, west of Williamsburg Sept, 1921 4401

LEERSIA VIRGINICA Willd Sphagnum bog, Chisel's Run, Aug 25, 1921 Roadside ditch, west of Williamsburg Oct, 1921 4311, 4599

LOLIUM MULTIFLORUM Lam Fields, around Williamsburg June 28, 1921 3879

LOLIUM PERENNE L Cultivated land, Williamsburg May and June, 1921 3623

LOLIUM TEMULENTUM L Roadside, near old Experiment Station, southwest of Williamsburg Only one plant May 30, 1921 3638

MUHLENBERGIA SCHREBERI Gmel Waste land, Williamsburg, and flood-plains of small streams Oct, 1921 4576, 4582

PANICUM AGROSTOIDES Spr Swamp along College Creek, south of Williamsburg Oct 3, 1920 3135

PANICUM AMARULUM Hitchc & Chase Along sandy shore at Newport News Sept 30, 1921 4502

PANICUM AMARUM Ell Banks of James River, at Camp Wallace Aug 18, 1921 4244

PANICUM ANCEPS Michx Wooded slope, Oct, 1920, and roadside, July 7, 1921, north of Williamsburg 3201, 3951

PANICUM ANGUSTIFOLIUM Ell Dry soil at edge of woods, near Williamsburg June 12, 1921 3689

PANICUM ASHEI Pears Flat pine-oak woods, west of Williamsburg, June 26, 1921 3852

PANICUM BARBULATUM Michx Flat pine-oak woods, west of Williamsburg, June 26, 1921 3847

PANICUM BOSCII Poir Woods west of Williamsburg, near Five Forks June, 1920 and 1921 2711, 3654

PANICUM CAPILLARE L Roadside, near Williamsburg July 17, 1921 4377

PANICUM CLANDESTINUM L Wooded flood-plain of Queen's Creek, north of Williamsburg June 17, 1921 3746

PANICUM CONDENSUM Nash Tidal marsh, Queen's Creek Aug 22, 1921 4303

PANICUM DEPAUPERATUM Muhl Dry pine-oak woods, near Williamsburg June 26, 1921 3845

PANICUM DICHOTOMIFLORUM Michx Along railway bank, near Lightfoot July, 1921 Edge of Jones' Mill Pond, Williamsburg Sept , 1921 4088, 4415

PANICUM HUACHUCAE var SILVICOLA Hitchc & Chase Dry soil, near Williamsburg June 13, 1921 3733

PANICUM LANUGINOSUM Ell Sandy fields, near Williamsburg June, 1921 3671, 3786

PANICUM LINDHEIMERI Nash Dry soil along C & O Railroad, near Williamsburg June 12, 1921 3688

PANICUM LUCIDUM Ashe Sphagnum-magnolia swamp, Chisel's Run, west of Williamsburg June, 1921 3764

PANICUM NITIDUM Lam Dry soil, near Williamsburg June 13, 1921 3732

PANICUM POLYANTHES Schultes Swampy places in woods, west of Williamsburg, June and Oct , 1921 Southeast of Ewell, Sept , 1921 3799, 4627, 4491

PANICUM SCOPARIUM Lam Dry field, west of Williamsburg June 22, 1921 Sphagnum swamp, near Ewell Sept 27, 1921 3785, 4467

PANICUM SPHAEROCARPON Ell Sandy waste places, around Williamsburg, May and June, 1921 3672, 3687, 3790

PANICUM VERRUCOSUM Muhl Moist soil, near Ewell Sept, 1921 4486

PANICUM VIRGATUM L Moist open ground, Williamsburg, edge of marshes at Queen's Creek, north of town July, 1921 3965, 4973

PANICUM XALAPENSE H B K Wooded flood-plain, near Williamsburg July 7, 1921 3960

PANICUM YADKINENSE Ashe Cleared hillside, south of Five Forks, James City Co, June 6, 1921 3652

PASPALUM CILIATIFOLIUM Michx Dry pine wood, near Williamsburg Sept 18, 1920 3022

PASPALUM DILATUM Poir Roadsides, Williamsburg June and Aug, 1921 3716, 4336

PASPALUM FLORIDANUM Michx Roadside, Williamsburg, Oct, 1920 Along railway, near Diascund, July 30, 1921 3218, 4176

PASPALUM LAEVE Michx Along bank of C & O Railroad, west of Williamsburg, July 1, east of Lanexa, July 30, 1921 Sandy soil 3906, 4148

PASPALUM PUBESCENS Muhl Dry pine woods, Williamsburg Sept, 1921 3022a, 4480

POA ANNUA L Williamsburg May 16, 1921 3564

POA AUTUMNALIS Muhl Moist wooded ravines, Williamsburg May, 1921 3544, 3577

POA COMPRESSA L Grass lands, Williamsburg

POA CUSPIDATA Nutt Wooded hillside, near Williamsburg March 25, 1921 3320

POA PRATENSIS L Rich moist soil, north of Williamsburg, May 23, 1921 3621

POA TRIVIALIS L Rich soil and swamps, near Williamsburg May, 1921 3606, 3624

SACCIOLEPIS STRIATA (L) Nash Bank of Chickahominy River, at Lanexa, July 30, 1921 4168

SETARIA GLAUCA (L) Beauv Fields and wooded slopes, west of Williamsburg July and Aug, 1921 4177, 4235

SETARIA IMBERBIS R & S Swampy woods, James City and York counties June, 1921 3796, 3870

SORGHASTRUM NUTANS (L.) Nash. Open oak slope, near Williamsburg. Sept. 19, 1920. 3956.

SPARTINA ALTERNIFOLIA GLABRA (Muhl.) Fern. Sandy shore, Newport News. Sept., 1921. Salt marshes, along York River north of Williamsburg. Oct., 1921. 4503, 4570.

SPARTINA CYNOSUROIDES (L.) Roth. Tidal marshes, below Jamestown Island, July 9, 1921. 3975.

SPARTINA PATENS (Ait.) Muhl. Tidal marshes, Queen's Creek Landing, Williamsburg. June 28, 1921. 3872.

SPHENOPHOLIS NITIDA (Spreng.) Scribn. Deep woods and moist ravines, around Williamsburg, May, 1920 and 1921. 2594, 2564, 3522.

SPHENOPHOLIS OBTUSATA (Michx.) Scribn. Dry soil at edge of woods, near Williamsburg. June 12, 1921. 3692.

SPOROBOLUS BERTERONIANUM (Trin.) Hitchc. & Chase. Williamsburg. July 5, 1921. 3948.

STIPA AVENACEA L. Edge of pine woods, near Williamsburg. May, 1920. 2616.

TRIDENS FLAVUS (L.) Hitchc. Sandy field, near Williamsburg. Oct., 1921. 4597.

TRIDENS STRICTUS (Nutt.) Nash. At edge of Mill Creek Pond, James City Co. Oct. 15, 1921. 4611.

TRIPSACUM DACTYLOIDES L. Flood-plain of James River, at Camp Wallace, July 5, 1921. 3937. Abundant.

TRISETUM PENNSYLVANICUM (L.) Beauv. Open swamps, York Co. Common. May 23, 1921. 3604.

UNIOLA LATIFOLIA Michx. Flat pine-oak woods, near Williamsburg. Frequent. Aug., 1921. 4223.

UNIOLA LAXA (L.) B. S. P. Flat pine-oak woods, around Williamsburg, Sept., 1920 and June, 1920. Rich woods, near Lanexa. July 30, 1921. 3108, 3841, 4144.

UNIOLA LONGIFOLIA Scribn. Hardwood slopes beside Jones' Mill Pond, Williamsburg. Sept., 1920 and 1921. 3038, 4417.

ZIZANIA PALUSTRIS L. Swamps along College and Queen's creeks, Williamsburg. Oct. 3, 1920. 3142, 3962.

CAREX ALATA Torr. Open swampy flood-plains, around Williamsburg. Mid-May, 1921. 3742, 3745, 3780.

Carex albolutescens Schwein Swamps, near Williamsburg Common Mid-June, 1921 3747, 3783, 3856

Carex bromoides Schkuhr Wooded flood-plain, south of Five Forks, May 17, 1921 3578

Carex cephalophora Muhl Rich shaded soil, west of Williamsburg, June 22, 1921 3795

Carex comosa Boott Open swamp, north of Williamsburg June 17, 1921 3748

Carex crinita Lam Sphagnum swamp, near Williamsburg June 12, 1921 3693

Carex debilis Michx var Rudgei Bailey Rich woods, west of Williamsburg June 16, 1921 3770

Carex decomposita Muhl Swamp along College Creek, Williamsburg July 3, 1921 3925

Carex Frankii Kunth Moist places, near Williamsburg July 7, 1921 3961

Carex grisea Wahlenb Swamp, Jones' Mill Pond, Williamsburg May 7, 1921 3541

Carex grisea var rigida Bailey Shady swamp, near Williamsburg June 10, 1920 2690

Carex hormathodes Fern Sandy flat, along Queen's Creek June 6, 1920 Chisel's Run, June 22, 1921 2659, 3791

Carex Howei Mackenz Wooded swamp at Chisel's Run May 1, 1921 3509

Carex incomperta Bickn Roadside at Chisel's Run May 1, 1921 3510

Carex intumescens Rudge Sphagnum swamp, southeast of Ewell July 1, 1921 3896

Carex laevivaginata (Kukenth) Mackenz Wooded ravine, north of Williamsburg June 28, 1921 3862

Carex laxiculmis Schwein Flood-plain of Chisel's Run May 1, 1921 3511

Carex laxiflora Lam Hardwoods, near Williamsburg May, 1921 3515, 3547

Carex leptalea Wahl Flood-plain, near Williamsburg May 7, 1921 3540

Carex lupulina Muhl Sphagnum swamp, southeast of Ewell July 1, 1921 3900

CAREX LURIDA Wahl Along streams, around Williamsburg Common June and July, 1920, 1921 2687, 2713, 3663 3807

*CAREX MITCHELLIANA M A Curtis Open swamp, west of Williamsburg June 16, 1921 3781

CAREX MUHLENBERGII Schk Wooded bank, near Williamsburg June 22, 1921 Dry sandy soil, along Chickahominy River at Lanexa July 30, 1921 3797, 4149

*CAREX OXYLEPIS Torr & Hook Hardwood slope south of Williamsburg May and June, 1921 3546, 3717

CAREX ROSEA Schkr Beech slope south end of Jamestown Road June 10, 1920 2680

CAREX SCOPARIA Schkr Common in open swamps, around Williamsburg

CAREX TRIBULOIDES Wahlb Swamp, south of Williamsburg June 11, 1921 3705

CAREX TRICEPS Michx var HIRSUTA (Willd) Bailey Dry soil, Williamsburg June, 1920 and 1921 2682, 3741

CAREX TRICEPS var SMITHII Porter Edge of woods, near Williamsburg June, 1921 3805, 3871

CAREX VARIA Muhl Dry hardwoods, near Williamsburg May, 1921 3525, 3550

CAREX VERRUCOSA Muhl Moist ground, southeast of Elko Sept 27, 1921 4490

CAREX VIRESCENS Muhl Stream bank, south of Williamsburg June 13, 1921 3714

CAREX VULPINOIDEA Michx Open swamps, near Williamsburg May and June, 1921 3609, 3661

CYPERUS CYLINDRICUS (Ell) Britt Cut-over woods, west of Williamsburg July 13, 1921 3994

CYPERUS FERAX Rich Swamp, Jones' Mill Pond, Williamsburg Sept , 1920 and 1921 Swamp at Carter's Creek and York River, Aug 20, 1921 3031, 4406, 4275

CYPERUS FILICULMIS Vahl Dry sandy flat, along Chickahominy River, at Lanexa July 30, 1921

CYPERUS FLAVESCENS L Ditch along railway, Williamsburg Sept 25, 1920 3103

CYPERUS GATESII Torr Tidal marsh, Carter's Creek, near York River Aug 20, 1921 4272

CYPERUS NUTTALLII Eddy Low ground along shore, Newport News Sept 30, 1921 4506

CYPERUS OVULARIS (Michx) Torr Barren field, near Williamsburg June 12, 1921 3698

CYPERUS PSEUDOVEGETUS Steud Moist roadside, near Williamsburg July 9, 1921 3973

CYPERUS RIVULARIS Kunth Ditch along railway, near Williamsburg Sept 25, 1920 3102

CYPERUS ROTUNDUS L Water-front near C & O Railroad station, Newport News Sept ,1921 4657

CYPERUS STRIGOSUS L Flat pine woods, near Williamsburg, and edge of marsh at Queen's Creek July, 1921 3969, 4064

DICHROMENA COLORATA (L) Hitchc Swamp along College Creek, Williamsburg July 3, 1921 3919

DULICHIUM ARUNDINACEUM (L) Britt Swampy flood-plain of Chickahominy River, at Lanexa July 30, 1921 4117

ELEOCHARIS CAPITATA (L) R Br Ditch beside railway, Williamsburg June 16, 1921 3774 (Extremely depauperate form only found, therefore probably the type form)

ELEOCHARIS ENGELMANNI Steud Damp soil in woods, northeast of Williamsburg June 11, 1921 3707

ELEOCHARIS OBTUSA (Willd) Schultes Moist shaded situations, James City Co , Sept , 1920, June, 1921 3021, 3706, 3709

ELEOCHARIS PALUSTRIS (L) R &' S Pine woods, north of Williamsburg June, 1920 and 1921 2660, 3708

ELEOCHARIS QUADRANGULATA (Michx) R & S Bank of Chickahominy River, Wilcox Neck, opposite Lanexa July 30, 1921 4125

ELEOCHARIS TUBERCULOSA (Michx) R & S Wet ditch along railway, west of Williamsburg Sept , 1920, June, 1921 3101, 3771

FIMBRISTYLIS SPADICEA (L) Vahl Tidal marsh, near mouth of Carter's Creek, York Co July 15, 1921 4017

FUIRENA HISPIDA Ell Sandy soil at edge of sphagnum swamp, five miles west of Williamsburg July 13, 1921 3993

KYLLINGA PUMILA Michx Edge of salt marsh, Carter's Creek at York River Aug, 1921 4261

RYNCHOSPORA CAPITELLATA (Michx) Vahl var DISCUTIENS (Clarke) Blake Low places in mixed woods, James City Co Oct 16, 1921 4619

RYNCHOSPORA MACROSTACHYA Torr Swamp along Chickahominy River, at Lanexa July 30, 1921 4155

SCIRPUS AMERICANUS Pers Tidal marshes, along Queen's Creek, College Creek and James River June, 1920 and 1921 2661, 3722, 3970

SCIRPUS ATROVIRENS Muhl var GEORGIANUS (Harper) Fernald Low ground at Chisel's Run June 22, 1921 3800

SCIRPUS CYPERINUS (L) Kunth Sandy soil at edge of sphagnum swamp, west of Williamsburg July 13, 1921 3985

SCIRPUS ERIOPHORUM Michx Roadside ditch, west of Williamsburg Oct 19, 1920 3176

SCIRPUS LINEATUS Michx Moist low grounds, Williamsburg June 12, 1921 3719

SCIRPUS NANUS Spreng In mud of tidal salt marsh, York River, at mouth of Carter's Creek July 15, 1921 4022

SCIRPUS OLNEYI Gray Tidal marsh, along Carter's Creek, half mile from York River May and July, 1921 3591, 4018

SCIRPUS ROBUSTUS Pursh In standing water, along Queen's Creek, and tidal marshes (brackish), at Carter's Creek, York Co July, 1921 3868, 4011

SCIRPUS VALIDUS Vahl Swamp along College Creek, Williamsburg June 13, 1921 3721

SCLERIA OLIGANTHA Michx Sandy soil of white oak woods, west of Williamsburg June and July, 1921 3662, 3920

SCLERIA PAUCIFLORA Muhl Sandy field and pine-barrens, near Williamsburg June, 1921 3701, 3839

SCLERIA TRIGLOMERATA Michx Sandy soil of thicket, two miles west of Williamsburg June 26, 1921 3843

STENOPHYLLUS CAPILLARIS (L) Britt Ballast along railway, at Williamsburg Sept 17, 1921 4397

ARISAEMA TRIPHYLLUM (L) Schott Flood-plains, throughout area, March and April, 1921 3354, 3439

ORONTIUM AQUATICUM L Slow shallow streams, north of Williamsburg March 24, 1921 3321

PELTANDRA VIRGINICA (L) Kunth Swampy flood-plain of small stream, south of Williamsburg May 9, 1921 3637

SYMPLOCARPUS FOETIDUS (L) Nutt Wooded flood-plain, south of Five Forks, James City Co, March, 1921 3338

LEMNA PERPUSILLA Torr Stagnant pool, near Ewell 1921

WOLFFIA COLUMBIANA Karst Floating, at edge of Jones' Pond, near Penniman, York Co, April 26, 1921 3493

* ERIOCAULON PARKERI Robinson Chickahominy River, near Lanexa July 30, 1921 4136

LACHNOCAULON ANCEPS (Walt) Morong Sphagnum swamp, at headwaters of Chisel's Run June 15, 1921

XYRIS CAROLINIANA Walt Wet sandy soil, along railway, west of Williamsburg July 1, 1921 3907

XYRIS ELATA Chapm Low woods, along Queen's Creek, York Co, July 22, 1921 4965

? XYRIS PLATYLEPIS Chapm Moist bank, east of Poplar Springs, Charles City Co Aug 6, 1921 4184

XYRIS TORTA Sm Wet sandy ditch, along railway, west of Williamsburg Sept, 1920 and June 16, 1921 3100, 3769

COMMELINA ERECTA L Loose sandy soil, at edge of woods, near Capitol Landing, Queen's Creek, July 22, 1921 4081

COMMELINA HIRTELLA Vahl Swampy flood-plains of Chickahominy River, at Lanexa June, 1921 4172a

COMMELINA VIRGINICA L Dry sandy field, Lanexa June 30, 1921 4172

PONTEDERIA CORDATA L In standing water, College Creek, Williamsburg Common June 13, 1921 3723

HETERANTHERA RENIFORMIS R & P In mud, along Chickahominy River, at Lanexa, July 30, 1921 Mud, at head of Jones' Mill Pond, Williamsburg Sept 20, 1921 4171, 4410

JUNCUS ACUMINATUS Michx Moist ground, Williamsburg June 10, 1921 3710

JUNCUS ARISTULATUS Michx Edge of tidal marsh, James River at mouth of College Creek July 9, 1921 3974

* JUNCUS ASPER Engelm Sphagnum-magnolia swamps, near Mount Pleasant Church, James City Co July 13, 1921, Oct 16, 1921 3992, 4616

JUNCUS BUFONIUS L Wet roadsides, near Williamsburg June, 1921 3743

JUNCUS CANADENSIS Gay Swamps, west of Williamsburg 1921 4040, 4287

JUNCUS DEBILIS Gray Wet soil in pine-oak woods, west of Williamsburg Oct, 1921 4621

JUNCUS DICHOTOMUS Ell Barren field, near Williamsburg June, 1921 3697

JUNCUS EFFUSUS L var COSTULATUS Fernald Swamps, near Williamsburg June, 1921 3749

JUNCUS MARGINATUS Rostk Barren field, near Williamsburg June 12, 1921 3704

JUNCUS ROEMERIANUS Scheele In water, at edge of James River, south of Williamsburg July 9, 1921 3977

JUNCUS SETACEUS Rostk Low grounds, near Williamsburg 1920, 1921 3043, 3718

JUNCUS SCIRPOIDES Lam Sandy soil, fields, near Williamsburg June, 1921 3699, 3898

JUNCUS TENUIS Willd Fields, near Williamsburg 1920, 1921 3711, 2701

LUZULA CAMPESTRIS (L) DC var BULBOSA Wood Dry pasture, near Williamsburg April 18, 1920 2524

* LUZULA SALTUENSIS Fernald Hardwoods, near Williamsburg April 9, 1921 3400

ALETRIS FARINOSA L Flat pine woods, west of Williamsburg May, 1921 3585, 3633

ALLIUM CANADENSE L Wooded flood-plain, north of Williamsburg June 11, 1921 3677

ALLIUM VINEALE L Fields, near Williamsburg June, 1920, 1921 2669, 3787

ASPARAGUS OFFICINALIS L Roadside, near Williamsburg May, 1921 3558

HEMEROCALLIS FULVA L Escape, along roadsides June, 1921

LILIUM CANADENSIS L Moist bank, west of Elko, Henrico Co Aug 6, 1921 4201

LILIUM SUPERBUM L Wooded swamp, at Longhill, James City Co Edge of swampy flood-plain of Chickahominy River, at Lanexa July, 1921 4109, 4157

MEDEOLA VIRGINIANA L Common in rich wooded flood-plains, around Williamsburg April and May, 1921 3474, 3566

MELANTHIUM VIRGINICUM L Deep wet woods, Chisel's Run, James City Co July 6, 1921 4044 Open marsh, near Elko, Aug 6 4204

MUSCARI RACEMOSUM (L) Mill Common weed in fields, Williamsburg April, 1920 2508

OAKESIA SESSILIFOLIA (L) Wats Rich soil of beech slope, north of Williamsburg April 26, 1921 3475

ORNITHOGALUM UMBELLATUM L Common weed in fields, around Williamsburg April, 1921

POLYGONATUM BIFLORUM (Walt) Ell Rich wooded hillsides, near Williamsburg May, 1920 and 1921 2577, 3529

POLYGONATUM COMMUTATUM (R & S) Dietr Rich woods, around Williamsburg, April, 1921 3472, 3597

SMILACINA RACEMOSA Desf Hardwoods, near Williamsburg April, 1921 3520

SMILAX BONA-NOX L Edge of pine woods, west of Williamsburg June, 1921 2633

SMILAX HERBACEA L Wooded ravine, south of Williamsburg April 24, 1921 3471

SMILAX HERBACEA L var PULVERULENTA (Michx) Gray Rich wooded hillside, Chisel's Run, James City Co , June 24, 1921 3823

SMILAX LAURIFOLIA L Edge of woods and marshes, along Queen's Creek and Carter's Creek, York Co March and Aug , 1921 3277, 4267

SMILAX ROTUNDIFOLIA L Moist roadside, north of Williamsburg May 16, 1920 2580

SMILAX TAMNIFOLIA Michx Sphagnum swamp, at Longhill, west of Williamsburg June 22, 1921 3806

UVULARIA PERFOLIATA L Openings in rich hardwoods, around Williamsburg May, 1920, April, 1921 2576, 3425

YUCCA FILAMENTOSA L Railway bank, one mile east of Diascund July 30, 1921 4114

ZYGADENUS GLABERRIMUS Michx Open marsh, west of Elko Aug 6, 1921 4200

DIOSCOREA GLAUCA Muhl Wooded flood-plain, southeast of Williamsburg May 2, 1921 3526

*DIOSCOREA QUATERNATA (Walt) Gmel Dry wooded hillside, near Williamsburg May 2, 1921 3527

DIOSCOREA VILLOSA L Woods near Williamsburg, and sphagnum swamp, at Longhill June, 1920 and 1921 2644, 3803

HYPOXIS HIRSUTA (L) Coville Sandy soil, in pine woods, around Williamsburg May 1, 1920 2544

NARCISSUS POETICUS L Hedgerow, south of Williamsburg April, 1921 3421

NARCISSUS PSEUDO-NARCISSUS L Waste places, southeast of Williamsburg

BELAMCANDA CHINENSIS (L) DC Roadside, just east of Williamsburg Sept , 1921 4578

IRIS VERNA L Sandy soil, at edge of pine-barrens, north of Williamsburg May 4, 1920, April 9, 1921 2553, 3396

IRIS VERSICOLOR L Common, in open swamps, Henrico Co 1921

SISYRINCHIUM ANGUSTIFOLIUM Mill Flat open oak woods, west of Williamsburg April 16, 1921 3427

SISYRINCHIUM GRAMINEUM Curtis Moist places, around Williamsburg May, 1920 and 1921 2585, 3608, 3763

? SISYRINCHIUM INTERMEDIUM Bickn Dry hardwood soil, west of Williamsburg June 10, 1921 3659

APLECTRUM HYEMALE (Muhl) Torr Rich moist woods, south and north of Williamsburg Occasional 3530 May, 1921 3551, 4650

CORALLORRHIZA ODONTORHIZA Nutt Rich wooded flood-plain, near Williamsburg Sept 17, 1921 4390

CYPRIPEDIUM ACAULE Ait Flat woods, around Williamsburg Frequent May, 1920, April, 1921 2528, 2561

CYPRIPEDIUM PARVIFLORUM var PUBESCENS (Willd) Knight Open oak woods around Williamsburg Occasional June, 1920, April, 1921 2647, 3410, 3430

EPIPACTIS PUBESCENS (Willd) A A Eaton Rich pine woods, around Williamsburg Sept, 1920 3975, 3121, 4008

HABENARIA CILIARIS (L) R Br Sphagnum swamps, west of Williamsburg, and moist bank along railway, west of Elko July, 1921 4063, 4100, 4179

HABENARIA CLAVELLATA (Michx) Spreng Wooded swamps throughout the Peninsula July, 1921 4009, 4026, 4150

HABENARIA CRISTATA (Michx) R Br Sphagnum-magnolia swamp, Chisel's Run, July 16, 1921 Moist bank along railway, east of Poplar Springs, Charles City Co Aug 6, 1921 4183, 4932

HABENARIA LACERA (Michx) R Br Deep woods in swamp, at Longhill, near Williamsburg-Centerville road June 23, 1921 3810

*HABENARIA REPENS Nutt Wooded swamp, along Chickahominy River, south of Lanexa July 30, 1921 4128

*HEXALECTRIS SPICATA (Nutt) Barnhart Shell marl bank, at edge of mixed woods, at head of Jones' Mill Pond, Williamsburg June 30, 1921 3915

LIPARIS LILIIFOLIA (L) Richard Woods, near Williamsburg June 1, 1920, May 9, 1921 3556, 2635

MICROSTYLIS UNIFOLIA (Michx) B S P Dry hardwoods, west of Williamsburg June 1, 1920 2634 Frequent

ORCHIS SPECTABILIS L Rich woods, near Williamsburg April and May, 1921 3454, 3516

*POGONIA AFFINIS Aust Open white oak woods, near Williamsburg June 1, 1920, May 9, 1921 2637, 3555 One station

POGONIA OPHIOGLOSSOIDES (L) Ker Sphagnum swamp at headwaters of Chisel's Run, James City Co June 15, 1921 3778

POGONIA VERTICILLATA (Willd) Nutt Mixed woods, along Jamestown Road and at Chisel's Run, James City Co April, 1920 and 1921 2557, 3463 Frequent

*PONTHIEVA RACEMOSA (Walt.) Mohr. Damp shaded ravine, west of Williamsburg. Sept. 19, 1920. Heavy calcareous soil of flood-plain thicket, north of Williamsburg. Sept. 17, 1921. 3078, 4386.

SPIRANTHES BECKII Lindl. Dry oak slope, along west side of College Creek, south of Williamsburg. Oct. 3, 1920. 3145.

SPIRANTHES CERNUA (L.) Richard. In tidal marsh along College Creek, south of Williamsburg. Sept. and Oct., 1921. 4446, 4595.

SPIRANTHES GRACILIS (Bigel.) Beck. Oak slope between Elko and Poplar Springs. Aug. 6, 1921. Dry field near Williamsburg. 4211, 4234.

SPIRANTHES VERNALIS Englm. & Gray. Dry sandy soil, west of Williamsburg and also near Ewell. 3826, 3911, 3905.

TIPULARIA DISCOLOR (Pursh) Nutt. Rich mixed woods, throughout. Frequent. Flowering Aug., 1921. 3266, 4072, 4236.

SAURURUS CERNUUS L. Shaded swampy areas, throughout. Abundant. June, 1921.

POPULUS ALBA L. Waste land, Williamsburg. 1920, 1921.

POPULUS DELTOIDES Marsh. Near Mount Pleasant Church, and beside Jones' Mill Pond, Williamsburg. May and Oct., 1921. 3572, 4591.

POPULUS HETEROPHYLLA L. Along James River, south of Williamsburg. 1921.

SALIX ALBA L. Swampy soil, Jones' Mill Pond, Williamsburg. April, 1921. 3417.

SALIX BABYLONICA L. Beside stream, one mile northwest of Williamsburg. Oct., 1921. 4645.

SALIX HUMILIS Marsh. Sandy soil, roadsides, York Co. March 13, 1921. 3276.

SALIX NIGRA MARSH. Stream banks, around Williamsburg. 3352, 3482.

SALIX TRISTIS Ait. Wooded uplands, west of Williamsburg. March and April, 1921. 3312, 3414.

MYRICA CAROLINENSIS Mill. Edge of dunes, at Cape Henry. Aug., 1921. (Not found on the Peninsula.) 4218.

MYRICA CERIFERA L. At edge of pine-barrens, throughout

Peninsula 1920 and 1921 2519, 3270, 3446 Flowering Feb 24, 1921

CARYA ALBA (L) K Koch Edge of flat pine woods, northwest of Williamsburg Oct 24, 1920 3227

CARYA LACINIOSA (Michx f) Loud Rich soil in mixed woods, northwest of Williamsburg 3180, 4655

JUGLANS CINEREA L Mixed woods, west of Williamsburg 1921

JUGLANS NIGRA L Williamsburg 1921

ALNUS RUGOSA (DuRoi) Spreng var SERRULATA (Ait) Winkler Sphagnum swamp, near Williamsburg Oct , 1920 Banks of Chickahominy River, near Lanexa, July, 1921 3197, 4139

BETULA NIGRA L North bank of Queen's Creek, Capitol Landing Bank near Jones' Mill Pond, Williamsburg Only two trees found May 19, 1921 3598

CARPINUS CAROLINIANA Walt Flood-plains, around Williamsburg July 7, 1921 3956

CORYLUS AMERICANA Walt Head of Jones' Mill Pond, Williamsburg

CORYLUS ROSTRATA Ait Chisel's Run flood-plain, west of Williamsburg July 23, 1921 4105

OSTRYA VIRGINIANA (Mill) K Koch Flood-plain woods, near Williamsburg

CASTANEA DENTATA (Marsh) Borkh Uplands around Williamsburg Many large trees killed by *Endothia*, 1919-1921

CASTANEA PUMILA (L) Mill Edge of woods, near Williamsburg Sept , 1920 3090 June, 1921 3696

FAGUS GRANDIFOLIA Ehrh Frequent on heavy soil, on the Peninsula

QUERCUS ALBA L Dry woods, around Williamsburg Sandy bank of Chickahominy River, at Lanexa July, 1921 3177, 3200, 4137

QUERCUS COCCINEA Muench Flat pine-oak woods, around Williamsburg Oct , 1921 4614, 4637

QUERCUS MARILANDICA Muench Sandy soil, at edge of pine-barrens, near Williamsburg Oct , 1920 3226

? QUERCUS MUHLENBERGII Engelm Calcareous bluff, James River, at Camp Wallace Aug, 1921 4245

QUERCUS MONTANA Willd (*Q Prinus* of authors) Edge of mixed woods four miles northeast of Williamsburg June 11, 1921 3682, 3213

QUERCUS NIGRA L Sandy bank of Chickahominy River, near Lanexa July 30, 1921 4138

QUERCUS PALUSTRIS Muench Swampy flood-plain, along railway, west of Roxbury, Charles City Co Aug 6, 1921 4192

QUERCUS PHELLOS L Sandy flat, on south bank of railway, northwest of Williamsburg Oct 19, 1920 3187

QUERCUS PHELLOS L var LAURIFOLIA (Michx) Chapm Sandy flat, one mile northwest of Williamsburg Oct 19, 1920 3186

QUERCUS PRINUS L (*Q Michauxii* Nutt) Edge of pine woods, west of Williamsburg Oct, 1920 Calcareous bluff, along James River, at Camp Wallace Aug 18, 1921 3119, 3926, 4251 Sandy slope, near mouth of Carter's Creek, York Co Oct 8, 1921 4549

QUERCUS RUBRA L (*Q falcata* Michx) Common in flat pine-oak woods, around Williamsburg 1920 and 1921 3228 Flowering, April 3, 1921

QUERCUS STELLATA Wang Edge of flat oak woods, around Williamsburg 1920 Calcareous bank, along James River, near Camp Wallace Aug 18, 1921 3079, 3215, 4247

QUERCUS VELUTINA Lam Flat sandy roadside, near Ewell, and same, west of Williamsburg Sept, 1921 4449, 4500, 4641

QUERCUS VIRGINIANA Mill Campus, College of William and Mary Large tree

BOEHMERIA CYLINDRICA (L) Sw Low ground, along College Creek, Williamsburg Flowering, July 3, 1921 3122, 3921

BROUSSONETIA PAPYRIFERA (L) Vent Waste land, Williamsburg 1921

? CELTIS GEORGIANA Small Flood-plain thicket, Queen's Creek, north of Williamsburg May, 1920, Oct, 1921 2584, 4564

CELTIS OCCIDENTALIS L Bank of Chickahominy River, near Lanexa, July 30, 1921 4134

MACLURA POMIFERA (Raf) Schneider Waste land, west of Williamsburg 1920

MORUS ALBA L Waste land, Williamsburg 1921

MORUS RUBRA L Moist flood-plains, west of Williamsburg Edge of marshes, York River, July, 1921 4021, 4327

PILEA PUMILA (L) Gray Shaded low ground, near Williamsburg Sept 20, 1921 4409

ULMUS ALATA Michx In loose sand along railway west of Ewell July 1, 1921 3913

ULMUS AMERICANA L Common, around Williamsburg, in moist ground 1921

ULMUS FULVA Michx Edge of mixed woods, near Williamsburg 1920 2689

URTICA GRACILIS Ait Waste shaded places, Williamsburg 1921 4654

PHORADENDRON FLAVESCENS (Pursh) Nutt Common, in swamps, along Queen's Creek, on Nyssa Bank of Chickahominy River, near Lanexa, on *Nyssa sylvatica* July 30, 1921 4121

ARISTOLOCHIA SERPENTARIA L Bassett Hall woods, Williamsburg June 1, 1920

ASARUM CANADENSE L Rich hardwoods, around Williamsburg April, 1921 2640, 3388

ASARUM VIRGINICUM L Rich hardwood slopes, around Williamsburg March, 1921 3292, 3397

FAGOPYRUM ESCULENTUM Moench Roadside, west of Williamsburg Oct, 1921 4642

POLYGONUM ACRE H B K Moist ground, Williamsburg June 23, 1921 Tidal marsh, Queen's Creek Aug 22, 1921 3812, 4306

POLYGONUM ARIFOLIUM L Wooded swamp, near Lanexa July 30, 1921 4124

* POLYGONUM DENSIFLORUM Meisn Edges of Mill Creek Pond, Jamestown Road Oct 15, 1921 4596

POLYGONUM ERECTUM L Cultivated grounds, Williamsburg 1921

POLYGONUM HYDROPIPEROIDES Michx Pond, near Williamsburg 1920 Swamp, southwest of Ewell June 2, 1921 3030, 3902

POLYGONUM LAPATHIFOLIUM L Beside pond, Williamsburg Sept , 1921 4414

POLYGONUM PERSICARIA L Cultivated grounds, Williamsburg 1921 3987

POLYGONUM PENNSYLVANICUM L var LAEVIGATUM Fernald Mud, beside pond, Williamsburg Oct 22, 1921 4651

POLYGONUM SAGITTATUM L Sphagnum-magnolia swamp, west of Williamsburg June 15, 1921 3766

POLYGONUM SCANDENS L Railway bank, at Diascund, July 30, 1921 Thicket, west of Williamsburg Sept 27, 1921 4164, 4468

POLYGONUM SETACEUM Baldw Edge of College Creek, Williamsburg Oct 17, 1921 3170

POLYGONUM VIRGINIANUM L Edge of rich woods, west of Williamsburg July 16, 1921 4035

RUMEX ACETOSELLA L Waste land, Williamsburg Flowering March 26, 1921

RUMEX ALTISSIMUS Wood Ballast, along railway, Williamsburg May, 1920 2611

RUMEX CONGLOMERATUS Murr In water of small stream, north of Williamsburg June 17, 1921 Edge of tidal marsh, along Queen's Creek, near Capital Landing July 17, 1921 3751, 3952

RUMEX CRISPUS L Waste land, Williamsburg, 1921

RUMEX OBTUSIFOLIUS L Waste land, Williamsburg June, 1921 3829

RUMEX PULCHER L Bright Farm, Williamsburg June 10, 1920 2692

RUMEX VERTICILLATUS L Cypress swamp, south of Five Forks May 30, 1921 3628

ATRIPLEX PATULA L var HASTATA (L) Gray Tidal marsh, along York River, at Carter's Creek Flowering Aug 20, 1921 4274

CHENOPODIUM ALBUM L Weed in waste places, Williamsburg Oct , 1921 4653

Chenopodium murale L Cultivated grounds, Williamsburg Oct , 1921 4615

Salicornia europaea L Tidal marsh, York River, at Carter's Creek Aug , 1921 4285

Salsola Kali L Sandy shore, Newport News, Sept , 1921 Dry sandy beach, York River, near Scimino Oct , 1921 4505, 4572

Acnida cannabina L Tidal marshes, Queen's Creek and York River, north of Williamsburg Aug 22, 1921 4301, 4286a

Amaranthus retroflexus L Common weed, Williamsburg

Phytolacca decandra L Common weed, Williamsburg

Scleranthus annuus L Weed in fields, Williamsburg April 3230, 3382

Mollugo verticillata L Common weed, Williamsburg 4482

Arenaria serpyllifolia L var tenuior Mert & Koch Corn-field, near Williamsburg April 29, 1920 2518

Cerastium viscosum L Common weed, Williamsburg April 3, 1921 3375

Cerastium vulgare L Fields, near Williamsburg April 9, 1921 3402

Dianthus Armeria L Grassy land, near Williamsburg Common June 9, 1921 2670

Lychnis alba Mill Waste land, near Williamsburg April, 1921 2599, 3495

Saponaria officinalis L Waste land, Williamsburg June 28, 1921 3867

Silene antirrhina L Cultivated fields, Williamsburg May 9, 1921 3553

Silene pennsylvanica Michx Sandy bank at south end of Mill Creek Pond, Jamestown Road May 9, 1920 2563 Sandy soil south of Williamsburg, April 12, 1921

Silene stellata (L) Ait f Rich woods near Lanexa, New Kent Co , and along College Creek, Williamsburg Aug , 1921 4120, 4345

Spergularia salina J & C Presl Shell heap on edge of tidal marsh, York River, north of Williamsburg July 15, 1921 4012

STELLARIA MEDIA (L.) Cyrill. Common in waste land, Williamsburg. 1921.

STELLARIA PUBERA Michx. Moist hardwood slopes, south of Williamsburg. April, 1921. 2510, 3394.

CLAYTONIA VIRGINICA L. Heavy soil of swampy flood-plain, at Chisel's Run, south of Williamsburg — Centerville Road. March 22, 1921. 3301. Also at Powhatan Creek, and at Jones' Pond near Penniman. Local.

PORTULACA OLERACEA L. Waste land, Williamsburg. 1921.

NYMPHAEA ADVENA Ait. Waller's Pond, north of Williamsburg. April 16, 1921. 3476.

ACTAEA ALBA (L.) Mill. Rich hardwood slopes, south and west of Williamsburg. May 2, and Aug. 25, 1921. 3519, 4324.

ANEMONE VIRGINIANA L. Wooded flood-plains, near Williamsburg. Sept., 1920, Aug., 1921. 3054, 4333.

ANEMONELLA THALICTROIDES (L.) Spach. Wooded slope north of Williamsburg. April, 1920, March 24, 1921. 2511, 3322.

AQUILEGIA CANADENSIS L. Edge of flat pine woods, northwest of Williamsburg. May 4, 1920. 2550.

CALTHA PALUSTRIS L. Jones' Mill Pond and College Creek, Williamsburg. April, 1920, March 17, 1921. 2504, 3291.

CIMICIFUGA RACEMOSA (L.) Nutt. Moist wooded ravine, near Williamsburg. June 24, 1921. 3819.

CLEMATIS PANICULATA Thunb. Escape, along roadside Williamsburg. Aug. 29, 1921. 4321.

CLEMATIS VIRGINIANA L. Low ground, at edge of thicket, Chisel's Run, west of Williamsburg. Aug. 25, 1921. 4319.

DELPHINIUM AJACIS L. Weed in cultivated fields, near Williamsburg and Grove. June 9, 1920, July, 1921. 2668, 3928.

HEPATICA TRILOBA Chaix. Wooded slopes, throughout. March 13, 1921. 3273.

RANUNCULUS ABORTIVUS L. Wooded flood-plain, near Williamsburg. March 26, 1921. 3341.

RANUNCULUS BULBOSUS L. Roadsides, Williamsburg. May 9, 1920. 2566.

RANUNCULUS HISPIDUS Michx. Wooded flood-plains, near Williamsburg. April, 1921. 3395, 3449.

RANUNCULUS HISPIDUS var FALSUS Fernald Flood-plain, south of Williamsburg April 24, 1921 3464

RANUNCULUS PARVIFLORUS L Field, near Williamsburg May 11, 1920 2570

RANUNCULUS RECURVATUS Poir Hardwood ravines, near Williamsburg June, 1920 April 17, 1921 2688, 3440

RANUNCULUS SCELERATUS L In streams and marshes, around Williamsburg May, 1920, June, 1921 2593, 3861

THALICTRUM POLYGAMUM Muhl Flood-plain swamps, at Longhill, Lanexa and Elko July, 1921 4086, 4158, 4203

THALICTRUM REVOLUTUM DC Shell marl banks in woods, near Williamsburg May 2, 1921 3557

LIRIODENDRON TULIPIFERA L Rich soil, throughout the Peninsula Flowering April 26, 1921 3485

MAGNOLIA TRIPETALA L Swampy flood-plains, east of Williamsburg May 16, 1920 May 2, 1921 2588, 3524

MAGNOLIA VIRGINIANA L Swampy ground, west of Williamsburg, and near York River Flowering May 19, 1921 3588, 3595

ASIMINA TRILOBA Dunal Rich woods, near Williamsburg

PODOPHYLLUM PELTATUM L Rich woods, near Williamsburg April 7, 1921 3387

BENZOIN AESTIVALE (L) Nees Woods, near Williamsburg April 4, 1921 2501

SASSAFRAS VARIIFOLIUM (Salisb) Ktze Fields and waste land, throughout

PAPAVER ARGEMONE L Waste ground, near Williamsburg May 30, 1921 3636

SANGUINARIA CANADENSIS L Woods, near Williamsburg April 4, 1920 2502

FUMARIA OFFICINALIS L Dry fields, Williamsburg May 1, 1920 2526

ARABIS VIRGINICA (L) Trel Corn-field, near Williamsburg March 19, 1921 3296

BARBAREA VERNA (Mill) Asch Fields around Williamsburg May 4, 1920 2537

BARBAREA VULGARIS R Br Corn-field, near Williamsburg April 21, 1921 3456

BARBAREA VULGARIS R Br var LONGISILIQUOSA Carion Alfalfa field, Williamsburg April 21, 1921 3457

BRASSICA ARVENSIS (L) Ktze Fields, near Williamsburg 1921

BRASSICA CAMPESTRIS L Fields, near Williamsburg April 3, 1921 3370

BRASSICA NIGRA (L) Koch Fields, near Williamsburg 1921

CAMELINA MICROCARPA Andrz Weed in alfalfa field, Williamsburg May 4, 1921 2538

CAPSELLA BURSA-PASTORIS (L) Medic Common, throughout the Peninsula 1921

CARDAMINE BULBOSA (Schreb) B S P Swampy flood-plains, James City and York counties March and April, 1921 3378, 3447

CARDAMINE DOUGLASSII (Torr) Britton Moist hardwoods, around Williamsburg March, 1921 3283, 3355

CARDAMINE HIRSUTA L Woods and roadsides, near Williamsburg March, 1921 3308, 3314, 3360

CARDAMINE PENNSYLVANICA Muhl Rich flood-plain, northwest of Williamsburg March 28, 1921 3359

CORONOPUS DIDYMUS (L) Sm Waste land, Williamsburg March 30, 1921 3367

DRABA VERNA L Corn-fields, near Williamsburg March 25, 1920 2500

LEPIDIUM CAMPESTRE (L) R Br Waste ground, Williamsburg 1921 3494

LEPIDIUM VIRGINICUM L Waste ground, Williamsburg 1921

RADICULA NASTURTIUM-AQUATICUM (L) Britt & Rend Stream, near Williamsburg June, 1921 3756

RAPHANUS RAPHANISTRUM L Fields, Williamsburg April 4, 1921 3384

SISYMBRIUM ALTISSIMUM L Ballast of railroad, Williamsburg 1921 3877

SISYMBRIUM THALIANUM (L) J Gay Field, near Williamsburg 1921 3376

* THLASPI ARVENSE L Alfalfa field, Williamsburg May 4, 1920 2534

SARRACENIA PURPUREA L Swampy woods, at Chisel's Run, near Williamsburg-Centerville Road July, 1921

* DECUMARIA BARBARA L Moist wooded ravines, James City County June 15, 1920 2709, 3972, 3423

HEUCHERA AMERICANA L Dry open oak woods, near Williamsburg June 1, 1921 2641

HYDRANGEA ARBORESCENS L Moist wooded hillsides, near Williamsburg Occasional June, 1920 and 1921 2706, 3816

ITEA VIRGINICA L Sphagnum swamps, James City Co May 9, 1921 3645, 3181

* PARNASSIA ASARIFOLIA Vent Open marsh, along railway, west of Elko One station Aug 6, 1921 4206

SAXIFRAGA PENNSYLVANICA L Swampy flood-plains, west of old battlefield, Williamsburg March 28, 1921 3353, 3448

SAXIFRAGA VIRGINIENSIS Michx Wooded slope, bank of James River, at Camp Wallace March 14, 1921 3280

TIARELLA CORDIFOLIA L Rich hardwood slopes, near Williamsburg May 20, 1920 2591

HAMAMELIS VIRGINIANA L Sandy slopes, hardwoods, near Williamsburg 1921 4220, 4547

LIQUIDAMBAR STYRACIFLUA L Moist oak woods, near Williamsburg Common May 20, 1920 2590

PLATANUS OCCIDENTALIS L Williamsburg Occasional 1921

AGRIMONIA MOLLIS (T & G) Britt Flood-plain thickets, around Williamsburg Aug , 1921 4079, 4344, 4382

AGRIMONIA PARVIFLORA Ait Rich woods, around Williamsburg Aug , 1921 4240 4395

AGRIMONIA ROSTELLATA Wallr White oak slope, near Williamsburg Sept , 1920 3016

AMELANCHIER CANADENSIS (L) Medic Mixed woods, west of Williamsburg March to May, 1921 3311, 3332, 3343, 3415, 3518

AMELANCHIER CANADENSIS × OBLONGIFOLIA (*fide* Wiegand) Edge of woods, around Williamsburg March, 1921 3289, 3309, 3328

AMELANCHIER OBLONGIFOLIA (T & G) Roem Dry sandy banks, near Williamsburg March, 1921 3287, 3302, 3313

? AMELANCHIER SERA Ashe Sandy hedgerow, west of Williamsburg May 9, 1920 2560

ARUNCUS SYLVESTER Kostel Shaded ravines, near Williamsburg June, 1920 2636

CRATAEGUS CRUS-GALLI L Bank of James River, below mouth of College Creek Scattering July 9, 1921 3971

CRATAEGUS OXYACANTHA L Field on Bright Farm, Williamsburg April 11, 1921 3416

? CRATAEGUS PHAENOPYRUM (L f) Medic Hedgerow northwest of Williamsburg One station No flowers, 1921

DUCHESNIA INDICA (Andr) Focke Waste ground, around towns 2655

FRAGARIA VIRGINIANA Duchesne Roadsides Abundant June 1, 1920 2642

GEUM CANADENSE Jacq Wooded flood-plains, James City Co 1921 3233, 3828

* GEUM CANADENSIS Jacq var GRIMESII Fernald & Weatherby Wooded flood-plains, near Williamsburg May, 1921 3583, 3605

GEUM FLAVUM (Port) Bickn Rich woods, west of Williamsburg June, 1921 3821, 3859

GILLENIA STIPULATA (Muhl) Trel Dry wooded slope, near Williamsburg May 29, 1920 2624

GILLENIA TRIFOLIATA (L) Moench Sandy huckleberry thickets, west of Williamsburg May, 1921 3549, 3642

POTENTILLA CANADENSIS L Waste ground, Williamsburg June 10, 1920 2685

POTENTILLA MONSPELIENSIS L Fields, near Williamsburg 1921

POTENTILLA PUMILA Poir Grassy places, near Williamsburg March, 1921 3364

PRUNUS AMERICANA Marsh Edge of woods, near Williamsburg 1921

PRUNUS AVIUM L Edge of flat pine woods, southeast of Williamsburg May 2, 1921 3521, 2590

PRUNUS PERSICA (L.) Stokes Roadside, near Chisel's Run March 22, 1921 3304

PRUNUS SEROTINA Ehrh Hedgerows, west of Williamsburg April 9, 1921 3401

PYRUS ARBUTIFOLIA (L.) L f Edge of flat woods, James City Co April 3, 1921 3373, 3331, 4484

PYRUS CORONARIA L Edge of pine woods, west of Mount Pleasant Church, James City Co April 17, 1921 Bank of Chickahominy River, at Lanexa, July 30, 1921 3435 4154

PYRUS MALUS L Edge of woods, in James City Co 1921

PYRUS MELANOCARPA (Michx.) Willd Damp woods, roadside at Chisel's Run March 28, 1921

ROSA RUBIGINOSA L Roadside at edge of woods, Jamestown Road 1921

ROSA PALUSTRIS Marsh Dry soil at edge of woods, south of Williamsburg About five feet high June 13, 1921 3724

ROSA VIRGINIANA Mill Open field, roadside, north of Williamsburg May 23, 1921 3620, 2684

RUBUS ARGUTUS Link [2] Roadside, north of Williamsburg April, 1921 3473

RUBUS BAILEYANUS Britt Swampy soil on edge of woods, old battlefield, Williamsburg April, 1921 3442

RUBUS CUNEIFOLIUS Pursh Dry open ground, near Williamsburg 3656, 3878

RUBUS ENSLENII Tratt Edge of flat pine woods, near Williamsburg 3433

RUBUS FLORIDUS Tratt Abundant beside woods and in floodplains, James City and York counties May to June, 1921 3441, 3512, 3648, etc

? RUBUS FLORIDUS Rich soil at edge of pine woods near Williamsburg April 26, 1921 3488

RUBUS NIGRICANS Rydb In a ploughed field, Williamsburg June, 1920 2703

RUBUS STRIGOSUS Michx Moist soil at edge of mixed woods south of Williamsburg April, 1921 3467

[2] All species of Rubus were determined by Dr P A Rydberg, 1924

ALBIZZIA JULIBRISSIN Durazz Bright Farm, Williamsburg July, 1921 4010

AMPHICARPA MONOICA (L) Ell Rich flood-plain thickets, throughout 4384

AMPHICARPA PITCHERI T & G Wooded flood-plains, throughout the Peninsula Sept, 1920 3040, 3134

ASTRAGALUS CANADENSIS L Dry open woods south James City Co July 5, 1921 3945

BAPTISIA TINCTORIA (L) R Br Dry soil on edge of pine woods, James City Co July 13, 1921 4006 3091

CASSIA CHAMAECRISTA L Abandoned sandy fields, near Williamsburg Oct 3, 1920 3125

CASSIA MARILANDICA L Flood-plain, near Williamsburg Aug 25, 1921 4332

CASSIA MEDSGERI Shafer Sandy soil, near Williamsburg Aug and Sept, 1921 4395

CASSIA NICTITANS L Sandy fields, near Williamsburg Sept 9, 1921 4360

CENTROSEMUM VIRGINIANUM (L) Benth Dry sandy soil, James City and York counties July, 1921 3940, 4080

CERCIS CANADENSIS L Wooded uplands, throughout the Peninsula York Co March 24, 1921 3319

CLITORIA MARIANA L Dry soil, throughout the Peninsula July 1, 1921 3912

CROTALARIA PURSHII DC Flat dry pine-oak woods, three miles west of Williamsburg One station June 26, 1921 3832

CROTALARIA SAGITTALIS L Occasional in sandy soil, along railway and roads, James City Co June and July, 1921 3833, 3910, 4095

CYTISUS SCOPARIUS (L) Link Sandy soil, along edge of pine woods, throughout the Peninsula May 4, 1920 2541 Flowering April 3, 1921

DESMODIUM CANESCENS (L) DC Moist woods, James City and York counties July 8, 1921 3950, 4112

DESMODIUM DILLENII Darl Dry oak woods, near Williamsburg Sept, 1920 3023

DESMODIUM GRANDIFLORUM (Walt) DC Rich woods along

bank of James River, at Camp Wallace Aug 18, 1921 4260

DESMODIUM NUDIFLORUM (L) DC Oak slopes, James City Co Sept 18, 1920 3019

DESMODIUM OBTUSUM (Muhl) DC Edge of flat pine woods, near Williamsburg Sept 25, 1920 3097

DESMODIUM PANICULATUM (L) DC Dry woods, around Williamsburg Sept, 1920 3099, 3045

DESMODIUM PAUCIFLORUM (Nutt) DC Rich moist woods around Williamsburg July and Aug, 1921 4175, 4322

DESMODIUM ROTUNDIFOLIUM (Michx) DC Open oak woods, near Williamsburg, Sept 18, 1920

DESMODIUM RIGIDUM (Ell) DC Flat pine woods, around Williamsburg Sept, 1920 3093

DESMODIUM VIRIDIFLORUM (L) Beck Dry woods, around Williamsburg 1920 Railway, east of Diascund, July 30, 1921 3020, 4113

GALACTIA VOLUBILIS (L) Britton Pine woods, James City Co Sept, 1920 3062

GLEDITSIA TRIACANTHOS L Waste land, Williamsburg 1920

GYMNOCLADUS DIOICA (L) Koch Williamsburg 1920

LATHYRUS VENOSUS Muhl Grassy moist bank, at Williamsburg railway station July, 1921

LESPEDEZA PROCUMBENS Michx Open pine woods, throughout the Peninsula Sept, 1920 3066, 3055

LESPEDEZA REPENS (L) Bart Railway, at Williamsburg Sept, 1920 3098

LESPEDEZA STRIATA (Thunb) H & A Edge of pine woods, James City Co Oct, 1920 3118

LESPEDEZA STUVEI Nutt Common in open pine woods, throughout the Peninsula Sept, 1920 3065

LESPEDEZA VIRGINICA (L) Britton Pine-barrens, throughout the Peninsula Oct, 1920 3095

*LOTUS CORNICULATUS L Roadside, at Camp Eustis, June 13, 1920 Pine woods, near Queen's Cr, York Co, June, 1921 2697, 3873

LUPINUS PERENNIS L Sandy banks, in pine-barrens, throughout the Peninsula Beginning to flower March 24, 1921 2562, 3478

MEDICAGO LUPULINA L Common, along roadsides June 1, 1920 2649

MEDICAGO SATIVA L Common, in fields, on railway banks and along roadsides

MELILOTUS ALBA Desr Moist soil, near Williamsburg June 30, 1921 3886

MELILOTUS OFFICINALIS (L) Lam Waste land, Williamsburg 1921

PSORALIA PEDUNCULATA (Mill) Vail Pine-barrens, around Williamsburg June 17, 1921 3755

RHYNCOSIA ERECTA (Walt) DC Pine-barrens, west of Williamsburg Sept, 1920 and July, 1921 3069, 4031

RHYNCOSIA TOMENTOSA (L) H & A Sandy bank along railway, northwest of Williamsburg July 2, 1921 4029

ROBINIA PSEUDO-ACACIA L Waste land, Williamsburg 1921

STROPHOSTYLES UMBELLATA (Muhl) Britt Open pine woods, around Williamsburg Sept, 1920 3070

STYLOSANTHES BIFLORA (L) B S P Open sandy soil, around Williamsburg Sept, 1920, July 17, 1921 3105, 4047

TEPHROSIA SPICATA (Walt) T & G Dry sandy soil, edge of pine woods, James City Co June 15, 1921 3882

TEPHROSIA VIRGINIANA (L) Pers Sandy roadsides, James City Co May 23, 1921 3587, 3613

TRIFOLIUM AGRARIUM L Roadside, east of Williamsburg June 10, 1921 3684

TRIFOLIUM ARVENSE L Roadsides, railway and abandoned fields, around Williamsburg May 30, 1921 2662, 3661

TRIFOLIUM HYBRIDUM L Moist grounds, around Williamsburg May, 1921

TRIFOLIUM INCARNATUM L Escaped in a few places near Williamsburg

TRIFOLIUM PRATENSE L Abundant along roadsides and in waste land

TRIFOLIUM PROCUMBENS L Fields, James City Co May 20, 1920 2598

TRIFOLIUM REPENS L Abundant in waste grounds 1921

ULEX EUROPAEUS L One thriving colony, near Jones' Mill Pond, Williamsburg June 10, 1920 2694

VICIA ANGUSTIFOLIA (L) Reich Hedgerow, near Williamsburg June 10, 1920 2681

VICIA CRACCA L Fields and roadsides, near Williamsburg June, 1921 3685

VICIA HIRSUTA (L) S F Gray Flood-plain, near Williamsburg May, 1920 2585

VICIA VILLOSA Roth Dry soil, near Williamsburg June, 1921 3752

LINUM FLORIDANUM (Planch) Trel var INTERCURSUM (Bickn) Weatherby Dry soil of mixed woods, beside Jones' Mill Pond, Williamsburg June 30, 1921 3889

LINUM MEDIUM (Planch) Britt Common, in sandy soil of roadsides 1921 3720, 4070

LINUM VIRGINIANUM L Openings in dry woods, frequent June, 1921

OXALIS EUROPAEA Jord Openings in woods, near Williamsburg June, 1921 3849

OXALIS STRICTA L Weed in sandy fields, Williamsburg May, 1920 2573

OXALIS VIOLACEA L Hardwoods, near Williamsburg April, 1921 3453

ERODIUM CICUTARIUM (L) L'Hér Weed in fields, Williamsburg March and April, 1921 3317, 3380

GERANIUM CAROLINIANUM L Roadsides, Williamsburg April 24, 1921 3469 A glandular form is common 2699

GERANIUM MACULATUM L Rich soil, at edge of woods near Williamsburg June 1, 1921 2643

AILANTHUS GLANDULOSA Desf Edge of town, Williamsburg Oct , 1920 3145

MELIA AZEDARACH L Flourishing tree in Williamsburg Probably northern limit

POLYGALA CRUCIATA L Sandy soil, west of Elko, Henrico Co , Aug 6, 1921 4190

POLYGALA INCARNATA L Edge of pine-barrens, near Williamsburg June 12, 1921 3702

POLYGALA LUTEA L Sandy swamps, James City Co June, 1921 3767, 3854

POLYGALA MARIANA Mill Dry flat woods, near Williamsburg June, 1921 3729

? POLYGALA SANGUINEA L One specimen, in pine-barrens, west of Williamsburg June, 1921

POLYGALA VERTICILLATA L Edge of pine-barrens, near Williamsburg June 12, 1921 3703

ACALYPHA GRACILENS Gray Sandy ballast of railway, near Poplar Springs, Charles City Co Aug 6, 1921 4215

ACALYPHA VIRGINICA L Weed in fields, Williamsburg Aug 29, 1921 4340

CROTON GLANDULOSUS L var SEPTENTRIONALIS Muell Arg Sandy corn-field, west of Williamsburg Sept 27, 1921 4488

EUPHORBIA COROLLATA L Shell bank, near Williamsburg June, 1920 Along railway, at Poplar Springs, Aug 6, 1921 2648, 4209

? EUPHORBIA COROLLATA L var MOLLIS Millsp Opening in hardwoods, near Williamsburg June 10, 1921 3665

EUPHORBIA MACULATA L Weed around Williamsburg 1921 4433

* EUPHORBIA MARILANDICA Greene Dry abandoned field, west of Williamsburg Sept 9, 1921 4361

EUPHORBIA PANICULATA Ell Dry roadside soil, south of Williamsburg July 5, 1921 3938

* EUPHORBIA PROSTRATA Ait Weed on old stone steps and pavements, Williamsburg Oct 16, 1921 4640

PHYLLANTHUS CAROLINIENSIS Walt Rich moist soil, west of Williamsburg Sept 9, 1921 4358

TRAGIA URENS L Barren burnt-over field, near Williamsburg July 17, 1921 4048

RHUS COPALLINA L Dry uplands, James City Co 1921

RHUS GLABRA L Edge of woods, James City Co June 30, 1921 3881

RHUS QUERCIFOLIA (Michx) Steud Sandy soil at edge of woods, near Williamsburg June 10, 1921 3667

RHUS TOXICODENDRON L Moist thickets, throughout 1921

RHUS TYPHINA L Dry upland thickets, throughout Oct 20, 1920 3212

RHUS VERNIX L Sphagnum swamp at Longhill, west of Williamsburg Locally abundant June, 1921

ILEX GLABRA (L) Gray Sandy flats, James City Co March, 1921 3310, 3325

ILEX OPACA Ait Woodlands, throughout Flowering May 27, 1921 2608

ILEX VERTICILLATA (L) Gray Shores of Jones' Mill Pond, Williamsburg Dec, 1920 3268

EUONYMUS AMERICANUS L Wooded flood-plains, James City Co Flowering May 5, 1921 3470

EUONYMUS ATROPURPUREUS Jacq Woods, around Williamsburg 1921 3923

STAPHYLEA TRIFOLIATA L Jones' Mill Pond shores, Williamsburg Flowering April 22, 1921

? ACER LEUCODERMA Small Calcareous bluff along James River, near Camp Wallace July 5, 1921 3929, 4250

ACER NEGUNDO L One tree, in hedgerow, Williamsburg 1921

ACER RUBRUM L Wooded flood-plains and dry uplands, throughout Flowering March 6, 1921 3271, 3349

ACER SACCHARINUM L Edge of mixed woods, west of Williamsburg Oct, 1921 3192

IMPATIENS BIFLORA Walt Along streams, throughout the Peninsula Aug 25, 1921 4342

CEANOTHUS AMERICANUS L Common in dry woods, throughout June 6, 1921 3647

PSEDERA QUINQUEFOLIA (L) Greene Common, in woods, throughout 1921

VITIS AESTIVALIS Michx Edge of woods, throughout the Peninsula 1921 4276, 4501, 3670

VITIS ROTUNDIFOLIA Michx Edge of thickets, James City Co, and flood-plain of Chickahominy River, at Lanexa, July 30, 1921 4170

VITIS CORDIFOLIA Michx Thickets, James City Co May 16, 1921 3569

TILIA AMERICANA L Roadside, Williamsburg June, 1921

HIBISCUS INCANUS Wendl Swampy flood-plain of Chickahominy River, at Lanexa July 30, 1921 4147 Also along James River

HIBISCUS MOSCHEUTOS L Tidal marshes, at Jamestown June, 1921 3981, 4256

HIBISCUS SYRIACUS L Escaped, around Williamsburg and Jamestown 1921

HIBISCUS TRIONUM L Weed, in gardens, Williamsburg July, 1921

KOSTELETZKYA VIRGINICA (L) Presl Marsh along James River, at Camp Wallace Flowering Aug 18, 1921 4254 Also along shore of York River

MALVA ROTUNDIFOLIA L Waste land, Williamsburg April, 1921

SIDA SPINOSA L Roadside, near York River, north of Williamsburg Aug 20, 1921 4284

* STEWARTIA PENTAGYNA L'Hér Dry wooded slope, along a stream south of Williamsburg June 24, 1921 3818

ASCYRUM STANS Michx Flat pine woods, throughout the region Aug 6, 1921 3063, 4207

ASCYRUM HYPERICOIDES L Open pine-barrens James City Co Aug, 1920 and 1921 3071, 4222

HYPERICUM CANADENSE L Sphagnum-magnolia swamps, James City Co June, 1921 4110, 3773

HYPERICUM GENTIANOIDES (L) B S P Dry sandy soil, James City Co 1921

HYPERICUM MUTILUM L Low grounds, James City Co July 15, 1921 4005

HYPERICUM PERFORATUM L Roadsides, throughout the Peninsula July, 1921 4074, 4162

HYPERICUM PUNCTATUM Lamb Waste land, James City Co July 5, 1921 3933

* HYPERICUM SETOSUM L Sandy pine-barrens, west of Williamsburg Infrequent Aug 15, 1921 4237

HYPERICUM VIRGINICUM L Sphagnum swamp, at head of Chisel's Run, James City Co Aug 25, 1921 4308

LECHEA RACEMULOSA Lam Dry open sandy soil, throughout Frequent Sept, 1921 4419, 4492

VIOLA AFFINIS Le Conte Hardwoods, south of Williamsburg April 17, 1920 2512

VIOLA ARVENSIS Murr Weed in alfalfa field, Williamsburg April 4, 1921 3499, 3381

VIOLA EMARGINATA Le Conte Sandy pine-barrens, near Williamsburg March 28, 1921 Swamp at Longhill, James City Co April 21, 1921 3334, 3399, 3459

VIOLA FIMBRIATULA Sm Bare cut-over land, west of Williamsburg March 22, 1921 3315

VIOLA HIRSUTULA Brainerd Dry soil in mixed woods, north of Williamsburg, James City Co April 17, 1921 3442

VIOLA PAPILIONACEA Pursh Common in wooded ravines, and in damp soil of roadsides March 17 to April, 1921 3285, 3335, 3391, etc

*VIOLA PEDATA L Sandy soil at edge of pine woods, three miles west of Williamsburg One station April 17, 1921 3437

VIOLA PEDATA L var CONCOLOR Th Holm Common, in sandy soil along roadsides May 4, 1920 2535 Flowering April 9, 1921

VIOLA PRIMULIFOLIA L Moist soil in pine-oak woods, west of Williamsburg, and sphagnum swamp, at Chisel's Run April 9 to June 16, 1921 3543, 3758

VIOLA RAFINESQUII Greene Roadside, on old battlefield, Williamsburg 3362 March 28, 1921

VIOLA SAGITTATA Ait Openings in flat oak woods, James City Co April 14 and July 23, 1921 3411, 4091

VIOLA SEPTEMLOBA × SORORIA One plant was collected near Williamsburg, March, 1921, and determined as a new hybrid by Dr Brainerd It possessed the foliage of *V septemloba* with pubescence of *V sororia*, and flowers intermediate between the two species We never observed *V septemloba* on the Peninsula

VIOLA SORORIA Willd Rich hardwoods soil, James City Co April, 1920 and 1921 2423, 3389

VIOLA SORORIA × TRILOBA Rich woods soil, near Williamsburg Two stations April, 1921 3404, 3413

VIOLA TRILOBA Schwein Sandy pine-barrens May 9, 1920 March 28, 1921 2558, 3351

*VIOLA VILLOSA Walt Sandy bank, in pine woods, three miles northeast of Williamsburg March 28, 1921 3356

PASSIFLORA INCARNATA L Fields and railway banks, James City Co June 15, 1921 3772

PASSIFLORA LUTEA L Flood-plain thicket, north of Williamsburg Oct 8, 1921 4565

OPUNTIA VULGARIS Mill Open sandy hillsides, north of Williamsburg, York Co, May 19, 1921 3603

AMMANIA KOEHNEI Britt Marsh, at mouth of Carter's Creek, on York River, Aug 20, 1921 4271

CUPHEA PETIOLATA (L) Koehne Dry field, Williamsburg July 3, 1921 3918

DECODON VERTICILLATUS (L) Ell Swampy shores of Jones' Mill Pond, Williamsburg Sept, 1920 and 1921 3033, 4403

LYTHRUM LINEARE L Tidal salt marshes of York River and tributaries Aug 22, 1921 4296

ROTALA RAMOSIOR (L) Koehne Wet ground, beside pond at Williamsburg Oct 12, 1921 4586

RHEXIA MARIANA L Moist roadside soil near Grove, James City Co June 5, 1921 3943

RHEXIA VIRGINICA L Sandy swamps, throughout the Peninsula Aug and Sept, 1921 3094, 4315, 4212

CIRCAEA LUTETIANA L Moist soil of clearings in woods, throughout the region June 23, 1921 3814

EPILOBIUM COLORATUM Muhl Moist low grounds, around Williamsburg Sept, 1921 4371, 4429

LUDVIGIA ALTERNIFOLIA L Low wet woods, near Williamsburg June 30, 1921 3883

LUDVIGIA LINEARIS Walt Moist ground near Elko, Henrico Co Aug 6, 1921 4187

LUDVIGIA PALUSTRIS (L) Ell Mud-flat, around pond at Williamsburg Oct 2, 1920 3123

OENOTHERA BIENNIS L Weed in fields, around Williamsburg Oct 8, 1921 4577

OENOTHERA FRUTICOSA L Sandy roadside, three miles west of Williamsburg June 26, 1921 3842

OENOTHERA LACINIATA Hill Waste land, around Williamsburg May, 1920 and 1921 2574, 3640

OENOTHERA LONGIPEDICELLATA (Small) Robinson Flat pine woods, west of Williamsburg May 18, 1921 3586

PROSERPINACA PALUSTRIS L In dried up pond bed, west of Elko, Henrico Co, Aug 6, 1921 4194

ARALIA RACEMOSA L Rich calcareous soil of shaded ravine, near Williamsburg Sept, 1920 Flowering June 30, 1921 3053, 3890

ARALIA SPINOSA L Common, in thickets, throughout the region 1921

HEDERA HELIX L Extensively escaped in woods, around Williamsburg 4061

PANAX QUINQUEFOLIUM L Rich hardwoods' slope, near Williamsburg Sept 19, 1920 3077 One station only

ANGELICA VILLOSA (Walt) B S P Edges of flat woods, James City Co June 13, 1921 3983

CICUTA MACULATA L Common, along streams Aug 27, 1921 4330

CRYPTOTAENIA CANADENSIS (L) DC Rich woods, James City Co Sept, 1921 3027 Flowering the last of June, 1921

DAUCUS CAROTA L Common in waste ground, throughout Flowering June 1, 1921

ERYNGIUM VIRGINIANUM Lam Tidal marshes of York River and tributaries Aug 22, 1921 4295

FOENICULUM VULGARE Hill Sandy shore of James River, along base of bluffs, at Camp Wallace July, 1921

HYDROCOTYLE RANUNCULOIDES L f In water of small stream, near Williamsburg Oct 12, 1921 4584

HYDROCOTYLE UMBELLATA L Edges of ponds and banks of streams, James City Co June 19, 1921 4056

HYDROCOTYLE VERTICILLATA Thunb Swampy wooded floodplain, of Chickahominy River, near Lanexa July 30, 1921 4156

*LILAEOPSIS LINEATA (Michx) Greene Mud of tidal marshes

of Queen's Creek, north of Williamsburg June 28, 1921 3863

OSMORHIZA LONGISTYLIS (Torr) DC Shore of Tutter's Neck Pond, Williamsburg April 21, 1921

OSMORHIZA LONGISTYLIS var VILLICAULIS Fernald Wooded ravines, near Williamsburg May 19, 1921 3601

OXYPOLIS RIGIDIOR (L) Coult & Rose Marsh along Queen's Creek, north of Williamsburg Oct 8, 1921 4548

PTILIMNIUM CAPILLACEUM (Michx) Raf Marshes along Chickahominy River, and Queen's Creek, near Williamsburg July and Aug, 1921 4119, 4294

SANICULA CANADENSIS L Dry woods, throughout the region June 13, 1921 3727 Southern small-leaved form

SANICULA MARILANDICA L Mixed woods, around Williamsburg June 22, 1921 3798 Southern small-leaved form

SIUM CICUTAEFOLIUM Schrank Swampy flood-plain of Chickahominy River July 30, 1921 4118

THASPIUM BARBINODE (Michx) Nutt Wooded ravine, near Williamsburg June 15, 1920 2705

CORNUS ALTERNIFOLIA L f Sandy-clay bank, near Williamsburg Flowering April 26, 1921 3539

CORNUS FLORIDA L Abundant in dry woods, throughout the Peninsula Flowering April 1, 1921 3409

CORNUS PANICULATA L'Hér Bank of College Creek, south of Williamsburg Oct 3, 1920 3132

CORNUS STRICTA Lam Edge of marshes, along College Creek south of Williamsburg Oct 3, 1921 3133

NYSSA SYLVATICA Marsh Common, on edge of woods, throughout the region April 26, 1921 3477, 3594, 4557

CHIMAPHILA MACULATA (L) Pursh Common, in dry woods, throughout the Peninsula Flowering June 10, 1921 3264, 3668

CHIMAPHILA UMBELLATA (L) Nutt Common, in dry woods, around Williamsburg June 15, 1920 2704

CLETHRA ALNIFOLIA L Wooded flood-plains, throughout the Peninsula July 30 and Aug 15, 1921 4123, 4221

EPIGAEA REPENS L Sandy banks and edge of pine woods, south of Williamsburg Frequent April 11, 1920 2506

GAULTHERIA PROCUMBENS L Occasional, in rich swampy forests Oct , 1921

GAYLUSSACIA BACCATA (Wang) C Koch Abundant as undergrowth in sandy flat pine woods, James City Co May 11, 1920 2587

GAYLUSSACIA DUMOSA (Andr) T & G Common in pine-barrens, James City Co Flowering in May, 1920 and 1921 2619, 3506

GAYLUSSACIA FRONDOSA (L) T & G Common, on edge of pine woods, James City Co Flowering April, 1921 3480, 3801, 4053

KALMIA LATIFOLIA L Forms thickets in rich sandy soil, throughout the Peninsula May 29, 1920 2617

LEUCOTHOË RACEMOSA (L) Gray Moist sandy soil on edge of pine woods, James City Co 2582, 2555

LYONIA LIGUSTRINA (L) DC Swampy thickets, west of Williamsburg June, 1921 3776, 3695

LYONIA MARIANA (L) D Don Thickets, along edges of pine woods, James City Co May 1920 2618, 2583

MONOTROPA HYPOPITYS L Rich woods, around Williamsburg Sept , 1920 and July 7, 1921 3048, 3959

MONOTROPA UNIFLORA L Shady beech woods, near Williamsburg June 10, 1920 2678

MONOTROPSIS ODORATA Ell Frequent, in flat oak woods of James City Co Flowering Feb 28 through March, 1921 Usually concealed by fallen leaves 3269, 3282, 3293

OXYDENDRUM ARBOREUM (L) DC Common, in dry upland mixed woods, James City Co June 10, 1920 2679, 3990

PYROLA ROTUNDIFOLIA L var AMERICANA (Sweet) Fernald Rich wooded hillsides, west of Williamsburg June, 1921 3779, 3824

RHODODENDRON NUDIFLORUM (L) Torr Open pine-barrens, and along edge of swamps, throughout the Peninsula May 1, 1920, April 11, 1921 2527, 3428

RHODODENDRON VISCOSUM (L) Torr Clearings, in rich swampy flood-plains, west of Williamsburg May 17, 1921 3579

VACCINIUM ATROCOCCUM (Gray) Heller Pine-oak woods, around Williamsburg April 17, 1920 2515 May, 1921 3593

Vaccinium corymbosum L Moist woods, James City Co 1921

Vaccinium neglectum (Small) Fernald Undergrowth in sandy soil of hardwoods, Jamestown Road April 11, 1921 3408 Flowers precocious

Vaccinium stamineum L Flat pine woods, throughout the region April, 1921 2581, 3434, 3429

Vaccinium vacillans Kalm Dry sandy woods throughout the region April, 1921 3407, 3326, 3725

Galax aphylla L Edge of thickets on sandy uplands, south of Williamsburg, and near mouth of Scimino Creek, at York River April 21, 1921 3324, 3465

Limonium carolinianum (Walt) Britt Tidal marshes, along the south shore of York River Aug 20, 1921 4278

Anagallis arvensis L Weed in corn-field, Williamsburg June 9, 1920 2666

Anagallis arvensis L var **caerulea** (Schreb) Ledeb Weed in field, Williamsburg April 26, 1921 3483

Lysimachia Nummularia L Moist grassy bank, near Jones' Mill Pond, Williamsburg June, 1921

Lysimachia quadrifolia L Rich soil of mixed woods, around Williamsburg June 1, 1920, May 23, 1921 2638, 3616

Lysimachia terrestris (L) B S P Edge of swamp, near Carter's Creek and York River June 6, 1920 2664

Samolus floribundus H B K Edges of shallow streams, throughout the region May 29, 1920 2630

Steironema ciliatum (L) Raf Moist woods, around Williamsburg June 9, 1921 3664

Steironema lanceolatum (Walt) Gray Edge of small pond, Ewell Sept 27, 1921 4481

Bumelia lycioides (L) Pers Edges of tidal marsh, at mouth of Carter's Creek, York River Aug 20, 1921 4269

Diospyros virginiana L Edge of flat pine woods, near Williamsburg May 23, 1921 3619

Fraxinus americana L Flood-plain of James River, James City Co Aug , 1921 4248

Chionanthus virginica L Occasional along streams, James City Co , May, 1921 3333, 3573

FRAXINUS AMERICANA L var ACUMINATA (Lam) Wesm Calcareous bluff, beside James River near King's Mill July 5, 1921 3930

FRAXINUS PENNSYLVANICA Marsh Flood-plains of streams, throughout the region June, 1921 3880

GELSEMIUM SEMPERVIRENS (L) Ait f Locally abundant, in swampy soil around Five Forks, James City Co May 9, 1920 2565

POLYPREMUM PROCUMBENS L Dry sandy fields, James City Co July, 1921 3979 4583

BARTONIA VIRGINICA (L) B S P Openings in sandy pine woods, near Williamsburg June 17, 1921 4049

GENTIANA SAPONARIA L Rich pine woods, along Jamestown Road Oct 14, 1920 3147

GENTIANA VILLOSA L Mixed woods, James City Co May, 1921

OBOLARIA VIRGINICA L Rich hardwood soil, southwest of Williamsburg March 15, 1921 3281

SABATIA ANGULARIS (L) Pursh Frequent, in abandoned fields and open ground, throughout the Peninsula July 9, 1921 3980, 4075

SABATIA DODECANDRA (L) B S P Edges of tidal marshes, along James and York rivers and tributaries July, 1921 3982, 4068

SABATIA PANICULATA (Michx) Pursh Frequent, in waste land, throughout the Peninsula July 1, 1921 3894, 3989

SABATIA STELLARIS Pursh In tidal marsh, at Capitol Landing and on Queen's Creek, York Co July 22, 1921 4076

? APOCYNUM MEDIUM Greene Dry soil along railway east of Lanexa July 30, 1921 4159

ACERATES VIRIDIFLORA Ell Dry soil, along railway, at Williamsburg Aug , 1921 Flowering June 28 3858, 4297

ASCLEPIAS AMPLEXICAULIS Sm Sandy woods, north of Williamsburg, June 28, and along railway at Lightfoot, July 23, 1921 3875, 4082

ASCLEPIAS INCARNATA L var PULCHRA (Ehrh) Pers Beside a stream, near Williamsburg Oct 20, 1920 3210 In flower, July 5, 1921

ASCLEPIAS PURPURASCENS L Sphagnum-magnolia swamps, west of Williamsburg June 23, 1921 3737, 3825

ASCLEPIAS TUBEROSA L Waste places, around Williamsburg Common June 11, 1921 3673

ASCLEPIAS VARIEGATA L Rich oak woods, near Williamsburg June 15, 1920 2708

ASCLEPIAS VERTICILLATA L Dry woods, north of Williamsburg Oct 2, 1920 3124

VINCETOXICUM CAROLINENSE (Jacq) Britt Sandy soil, in open places along old roads Frequent June 10, 1921 3666, 3690

CONVOLVULUS ARVENSIS L Ballast along railway, at Williamsburg May 27, 1920 2610

CUSCUTA GRONOVII Willd On *Boehmeria cylindrica*, at edge of pond, near Williamsburg Common in moist woods Sept 20, 1921 4418

CUSCUTA PENTAGONA Engelm Frequent in abandoned fields, near Williamsburg Aug 15, 1921 4230

IPOMOEA COCCINEA L Common corn-field weed Oct 2, 1920 3116

IPOMOEA HEDERACEA Jacq Common weed, throughout Oct 12, 1921 4585

IPOMOEA PANDURATA (L) Mey Hedgerows, near Williamsburg July, 1921

PHLOX MACULATA L Wooded swamp at Longhill, James City Co July 23, 1921 4108

POLEMONIUM REPTANS L Swampy flood-plains, north of Williamsburg March 28, 1921 3361

CYNOGLOSSUM VIRGINIANUM L Dry oak woods, James City Co May, 1920, 1921 2589, 2646

ECHIUM VULGARE L Abundant, in cultivated fields, near Williamsburg June 9, 1920 2667

LAPPULA VIRGINIANA (L) Greene Thickets along streams, James City Co Aug 20, 1921 4280

LITHOSPERMUM ARVENSE L In alfalfa field, near Williamsburg May 4, 1920 2536

MYOSOTIS ARVENSIS (L) Hill Dry open woods, south of Williamsburg. May 9, 1921 3548

MYOSOTIS LAXA Lehm In shallow water of ponds and streams, throughout the region May, 1920 and 1921 2626, 3574

ONOSMODIUM VIRGINIANUM (L) DC Dry open oak woods, near Williamsburg June 1, 1920 2650

CALLICARPA AMERICANA L Frequent, in rich woods, James City Co Fruit, Oct 3, 1920 3126

VERBENA ANGUSTIFOLIA Michx Weed in dry fields, throughout the Peninsula June, 1921 3716, 3738

VERBENA URTICAEFOLIA L Moist thickets, throughout the region June, 1921 3794, 4067

* AJUGA CHAMAEPITYS (L) Schreb Calcareous sandy bank, at mouth of Carter's Creek, York River July and Aug, 1921 4020, 4273

BLEPHILIA CILIATA (L) Raf Opening in dry hardwoods, near Williamsburg July 21, 1921 4174

LAMIUM AMPLEXICAULE L Common weed, Williamsburg 1920–21

LEONURUS CARDIACA L Common weed, Williamsburg 1920–21

LYCOPUS AMERICANUS Muhl Edge of marshes, Queen's Creek, north of Williamsburg Aug 22, 1921 4290

MENTHA ARVENSIS L Moist hedgerow, near Williamsburg June, 1921

MENTHA CITRATA Ehrh Low moist ground beside Jones' Mill Pond, Williamsburg Flowering Aug 31, 1921 4411

MENTHA PIPERITA L Wet swampy flood-plains, around Williamsburg July 17, 1921 4057

MENTHA SPICATA L Moist grounds, near Williamsburg July 17, 1921 4058

MONARDA PUNCTATA L Dry soil, throughout the Peninsula Aug, 1921 4305

NEPETA CATARIA L Abandoned garden, at mouth of Scimino Creek, York Co Oct 8, 1921 4559

NEPETA HEDERACEA (L) Trevisan Weed in moist places, Williamsburg April 7, 1921 3390

PERILLA FRUTESCENS (L) Britt Waste land on Duke of Gloucester St, Williamsburg Sept 24, 1921 4457

PRUNELLA VULGARIS L Moist grounds and roadsides, throughout the region May 30, 1921 3632

PYCNANTHEMUM FLEXUOSUM (Walt) B S P Dry grounds, throughout the Peninsula Flowering July 5, 1921 3932

PYCNANTHEMUM INCANUM (L) Michx Dry wood, at Lanexa, July 30, and dry thicket, near Williamsburg July 31, 1921 4173

SALVIA LYRATA L About houses, along roadsides and even in wooded ravines Abundant May, 1920–1921 2540, 2568

SATUREJA NEPETA (L) Scheele Cultivated land, Williamsburg Oct , 1920 3223

SCUTELLARIA CANESCENS Nutt Moist hardwoods, around Williamsburg June 26, 1921 3830, 3892

SCUTELLARIA INTEGRIFOLIA L Sandy soil, on edge of woods, near Williamsburg June 5, 1921 3644

SCUTELLARIA LATIFLORA L Swampy flood-plains of Chickahominy River and Chisel's Run July, 1921 4111, 4130

SCUTELLARIA PILOSA Michx Sandy bank, along Jamestown Road May 30, 1921 3629

STACHYS PALUSTRIS L Rich hedgerows, around Williamsburg 1921

TEUCRIUM CANADENSE L Flood-plain of James River, near Camp Wallace July 5, 1921 3946

TRICHOSTEMA DICHOTOMUM L Dry field, near Williamsburg Sept 13, 1921 4379

DATURA STRAMONIUM L Common in waste land, Williamsburg 1921

DATURA TATULA L Common weed, Williamsburg July, 1921

PHYSALIS PRUINOSA L Dry sandy open soil James City Co July, 1921

PHYSALIS VIRGINIANA Mill Weed around Williamsburg July, 1921

SOLANUM CAROLINENSE L Common weed, in waste land, Williamsburg July, 1921

SOLANUM DULCAMARA L Hedgerows, near Williamsburg June, 1921

SOLANUM NIGRUM L Rich moist soil, around Williamsburg July, 1921

SOLANUM ROSTRATUM Dunal Weed in fields, near Williamsburg July, 1921

AGALINIS HOLMIANA (Greene) Pennell Edge of sandy pine woods Sept 25, 1920 3104

AGALINIS PURPUREA (L) Britt Abundant in tidal marshes of Peninsula Aug 22, 1921 4300

AUREOLARIA FLAVA (L) Farwell Dry woods, throughout the Peninsula Began to flower June 15, 1921 3815, 3846

AUREOLARIA PEDICULARIA (L) Raf Sandy soil of oak thicket, near Williamsburg Sept 9, 1921 4357

BACOPA ACUMINATA (Walt) Robinson Wet soil, common west of Elko Aug 6, 1921 4186

CHELONE GLABRA L Beside streams and in swamps, throughout the region Aug and Sept , 1921 4373

*CHELONE GRIMESII Weatherby Wooded swamp between Poplar Springs and Elko, Henrico Co Aug 6, 1921 4189

GRATIOLA PILOSA Michx Dry cut-over woods, west of Williamsburg July 13, 1921 4001

GRATIOLA SPHAEROCARPA Ell Swampy flood-plain, near Williamsburg June, 1921

GRATIOLA NEGLECTA Torr In wet mud by stream, west of Williamsburg May 17, 1921 3581

LINARIA CANADENSIS (L) Dumont Sandy banks and roadsides, throughout the Peninsula May, 1920, July, 1921 2548, 4163

LINARIA ELATINE (L) Mill Wéed in cultivated ground, Williamsburg July 3, 1921 3917

LINARIA SPURIA (L) Mill Waste land, Williamsburg June 15, 1921

LINARIA VULGARIS Hill Roadsides, throughout the region July 30, 1921

MIMULUS ALATUS Ait Swampy flood-plains, James City Co Flowering July 19, 1921 4412

MIMULUS RINGENS L Swampy flood-plains, throughout the region July and Sept , 1921 4066, 4432

PAULOWNIA TOMENTOSA (Thunb) Steud Edge of pine woods, near Williamsburg Flowering April 12, 1921 3420

PEDICULARIS CANADENSIS L Roadsides and dry oak woods, throughout June 1, 1920, March 28, 1921

PEDICULARIS LANCEOLATA Michx Abundant in swampy flood-plains, throughout the region Sept 23, 1921 4464

PENTSTEMON HIRSUTUS (L) Willd Dry clayey bluff, along shore of York River at Penniman May, 1921

PENTSTEMON PALLIDUS Small Rich moist flood-plain of Queen's Creek, north of Williamsburg May 23, 1921 3610

SCROPHULARIS MARILANDICA L Edge of moist woods, James City Co Sept 9, 1921 4348

VERBASCUM BLATTARIA L Waste land, Williamsburg 1921

VERBASCUM THAPSUS L Weed throughout the region 1921

VERONICA AGRESTIS L Weed in sandy fields, Williamsburg April, 1921

VERONICA ANAGALLIS-AQUATICA L In a small stream, near Williamsburg Oct 17, 1920

VERONICA ARVENSIS L Weed in waste land, around Williamsburg Fruit, May 16, 1921 3565

VERONICA OFFICINALIS L Dry pine woods, James City Co May 27, 1920 2615

VERONICA GLANDIFERA Pennell Wet ground along edge of Jones' Mill Pond, Williamsburg Oct 12, 1921 4587

VERONICA PEREGRINA L Weed in cultivated grounds, Williamsburg Fruit, May 16, 1921 3563

VERONICA PERSICA Poir Weed in fields, Williamsburg April 17, 1921 2513

? UTRICULARIA INFLATA Walt Floating in a ditch, Elko Aug, 1921 4216

EPIFAGUS VIRGINIANA (L) Bart Beech woods, throughout the region Common Oct 2, 1920 3111

BIGNONIA CAPREOLATA L Wooded flood-plains and moist woods, throughout the Peninsula May 17, 1921 3580

CATALPA BIGNONIOIDES Walt Hedgerows, near Williamsburg 1921

TECOMA RADICANS (L) Juss Hedgerows and thickets, throughout the region

RUELLIA CILIOSA Pursh Dry soil along roadsides and borders of woods, James City Co June 16, 1921 3777, 3887

Ruellia strepens L Rich hillside, near Williamsburg June 6, 1921 3655

Phryma Leptostachya L Rich moist woods, throughout Flowering June 24, 1921

Plantago aristata Michx Dry sandy soil of roadside, two miles west of Williamsburg July 9, 1921 3968

Plantago lanceolata L Common in waste land, throughout

Plantago major L Common in waste lands, throughout Oct, 1921 4649

Plantago Rugelii Dcne Moist waste land, Williamsburg Aug 14, 1921 Fruit

Plantago virginica L Weed in fields, around Williamsburg April, 1920 2517

Cephalanthus occidentalis L Shores of Jones' Mill Pond, Williamsburg June 30, 1921 3891

Diodia teres Walt Sandy waste land, throughout the region July 15, 1921 4014

Diodia virginiana L Moist roadside ditches, James City Co July 5, 1921 3942

Galium Aparine L Rich waste ground and wooded thickets, around Williamsburg May 23, 1921 3615

Galium circaezans Michx var glabrum Britton Dry beech woods, near Williamsburg June 10, 1921 3678

Galium Claytoni Michx Moist ditches and swampy floodplains, around Williamsburg June, 1921 3676, 3757

Galium pilosum Ait var puncticulosum (Michx) T & G Dry barren burnt-over land, northwest of Williamsburg June 15, 1921 3739

Galium triflorum Michx Rich mixed woods, near Williamsburg Sept 18, 1920 3028

Houstonia caerulea L Mossy hardwoods' soil, throughout the region April, 1920 and 1921 2505, 3505

Houstonia longifolia Gaertn Dry gravelly soil along railway, Charles City Co Aug 6, 1921 4198

Houstonia purpurea L Oak woods, around Williamsburg June, 1920 2710

Mitchella repens L Open pine and oak woods, throughout the region June 1, 1920 2654

* SHERARDIA ARVENSIS L In grass of orchard, Williamsburg June 10, 1920 2691 Flowering April 5, 1921

LONICERA JAPONICA Thunb Abundant in hedgerows and pine woods, throughout the region May 27, 1920 2609

LONICERA SEMPERVIRENS L Moist thickets, throughout the region May 1, 1920 2529

SAMBUCUS CANADENSIS L Rich open soil, throughout the region June 17, 1921 3750

SYMPHORICARPOS ORBICULATUS Moench Dry clayey bank, along railway, near Williamsburg Fruit Dec 19, 1920 3256

TRIOSTEUM PERFOLIATUM L Edge of sandy woods, near Williamsburg May 16, 1921 3568

VIBURNUM ACERIFOLIUM L Dry wooded slopes, around Williamsburg Oct, 1920 and May 2, 1921 3144, 3523

VIBURNUM CASSINOIDES L Wooded swamps, along Carter's Creek, York Co Oct, 1921 4556

VIBURNUM DENTATUM L Swampy island in Chickahominy River, at Lanexa July 30, 1921 4133

VIBURNUM NUDUM L Wooded swamps, around Williamsburg Oct, 1920 and May 19, 1921 3185, 3589

VIBURNUM PRUNIFOLIUM L Abundant in wooded swamps and hillsides, Chisel's Run April 3, 1921 3371

VIBURNUM RUFIDULUM Raf Rich woods, Oaktree, York Co May 19, 1921 3596

VALERIANELLA LOCUSTA (L) Betcke Roadsides and grassy places, around Williamsburg April 17, 1921 3451

VALERIANELLA RADIATA (L) Dufr Low ground, along streams, around Williamsburg April and May, 1921 3504, 3545

MELOTHRIA PENDULA L Calcareous wooded bank west of Williamsburg July, 1921 Hampton, collected by L G Tennis, Aug, 1921

CAMPANULA AMERICANA L Moist wooded ravine, along James River, at Camp Wallace Aug 18, 1921 4255

SPECULARIA PERFOLIATA (L) A DC Weed in fields, throughout May, 1921 3627

LOBELIA AMOENA Michx Sphagnum-magnolia swamp at Chisel's Run, James City Co July 16, 1921 4039

LOBELIA CARDINALIS L Swampy flood-plains, York Co July 7, 1921 3958

LOBELIA INFLATA L Openings in flat pine woods, around Williamsburg July 13, 1921 4002

LOBELIA NUTTALLII R & S Sandy soil of sphagnum swamps, James City Co June and July, 1921 3857, 3901

LOBELIA PUBERULA Michx Rich sandy woods, James City Co Sept, 1920, Aug and Sept, 1921 3067, 4289, 4434

LOBELIA SIPHILITICA L Swampy soil on edge of Jones' Mill Pond, Williamsburg Oct 12, 1921 4589

ACHILLEA MILLEFOLIUM L Common, in waste places, Williamsburg

ACTINOMERIS ALTERNIFOLIA DC Rich wooded flood-plains, at Tutter's Neck Pond and Camp Wallace, James City Co Aug and Sept, 1921 4463

AMBROSIA ARTEMISIIFOLIA L Roadside weed, Williamsburg

AMBROSIA TRIFIDA L Weed, in moist waste land, Williamsburg

ANTENNARIA ARNOGLOSSA Greene Opening on hardwood slope one mile north of Williamsburg April 17, 1920 2516

ANTENNARIA FALLAX Greene Dry sandy roadside bank, near Williamsburg May 11, 1920 2540

ANTENNARIA PARLINII Fernald Grassy railway embankment, near East Williamsburg May 27, 1920 2614

ANTENNARIA PLANTAGINIFOLIA (L) Richards Sandy roadside banks, and at edge of pine woods, around Williamsburg May, 1920 2545, 2569

? ANTENNARIA SOLITARIA Rydb East shore of College Creek, at Landing April 12, 1921 3419

ANTHEMIS ARVENSIS L Old field, near Williamsburg June 15, 1920 2700

ANTHEMIS COTULA L Roadsides, Williamsburg June

ARCTIUM LAPPA L Common, in waste places, throughout the region

ARNICA ACAULIS (Walt) B S P Edge of flat sandy pine-oak woods, near Williamsburg May 8, 1921 2621, 3542

ARTEMISIA ANNUA L Common in waste places, Williamsburg July, 1922

ASTER CONCINNUS Willd Dry open roadside, west of Williamsburg June 24, 1921 3827

ASTER CORDIFOLIUS L Rich hardwoods, around Williamsburg Oct, 1920 3158

ASTER CORDIFOLIUS var POLYCEPHALUS Porter Rich wooded slope, west of Williamsburg Oct 15, 1921 4594

? ASTER CORDIFOLUS × UNDULATUS Wooded slope, near Williamsburg Oct, 1920 3204

ASTER DUMOSUS L Dry railway embankment, just west of Lightfoot Sept 27, 1921 4497

ASTER ERICOIDES L Very common Weed in fields abandoned one year Oct 24, 1920 3232, 4428

ASTER GRACILIS Nutt Edge of mixed woods, near Williamsburg Sept 9, 1921 4353

ASTER GRANDIFLORUS L Sandy roadside banks near Williamsburg Oct 19, 1920 3178 Common

ASTER INFIRMUS Michx Dry woods, James City Co Flowering third week in July, 1921 4103

ASTER LINARIIFOLIUS L Sandy banks along roadsides, near Williamsburg Sept and Oct, 1921 3084, 3179

ASTER LATERIFLORUS (L) Britton Sandy soil of thickets, James City and York counties Oct, 1920 and 1921 3149, 4558

ASTER PATENS Ait Dry oak slope, near Williamsburg Oct 17, 1920 3160

ASTER PUNICEUS L Swampy flood-plains of College Creek, south of Williamsburg Oct, 1920, Sept, 1921 3137, 4422

ASTER SUBULATUS Michx Tidal marshes of James and York Rivers Sept 23, 1921 4424

ASTER TENUIFOLIUS L Salt marsh along York River, at Scimino Creek Oct 8, 1921 4560

ASTER UMBELLATUS Mill Sphagnum-magnolia swamp, at Longhill, James City Co Sept 27, 1921 4478

ASTER UNDULATUS L Dry wooded slopes, throughout the region Frequent Oct, 1920, Sept, 1921 3150, 3155, 4454

ASTER VIRGATUS Ell Open hardwood slopes, around Williamsburg Frequent Sept , 1920 and 1921 3049, 4450

BACCHARIS HALIMIFOLIA L Cleared pine-barren, just north of Williamsburg Sept 25, 1920 Edge of tidal marshes, along York River Oct 1, 1921 3109, 4561

BIDENS TRICHOSPERMA (Michx) Britt (Now *B coronata* (L) Britt) Tidal marshes along Queen's Creek, north of Williamsburg Aug 22, 1921 4291

BIDENS FRONDOSA L Swampy ground, near Williamsburg Oct , 1920 3209

BIDENS LAEVIS (L) B S P Swampy ground, Jones' Mill Pond, Williamsburg Nov 5, 1920 3241

BOLTONIA ASTEROIDES (L) L'Hér Oak slopes and dry woods, around Williamsburg July and Aug , 1921

BORRICHIA FRUTESCENS (L) DC Sandy shore of York River, at Penniman July, 1922

CACALIA ATRIPLICIFOLIA L Sandy soil, at edge of mixed woods, near Williamsburg Sept , 1920 3205, 3061

CHRYSANTHEMUM LEUCANTHEMUM L var PINNATIFIDUM Lecoq & Lamotte Common weed in fields, throughout the Peninsula Flowering May 18, 1921

CHRYSOGONIUM VIRGINIANUM L Rich oak slope, north shore of Tutter's Neck Pond, Williamsburg April 20, and June 24, 1921 3817

* CHRYSOPSIS ASPERA Shuttl Open situations, on edge of woods, in dry clay soil, around Williamsburg Frequent Sept , 1920 and 1921 3044, 4356

? CHRYSOPSIS GOSSYPINA (Michx) Nutt Dry woods, near Williamsburg Sept , 1920 3017

CHRYSOPSIS GRAMINIFOLIA (Michx) Nutt Dry sandy roadside, near the ferry, Newport News Sept 30, 1921 4504

CHRYSOPSIS MARIANA (L) Nutt Dry woods and roadside banks, James City and York counties Sept , 1920, June 26 and Aug , 1921 3047, 4335 Common

CICHORIUM INTYBUS L Roadside, Williamsburg Occasional

CIRSIUM DISCOLOR (Muhl) Spreng Rich roadside soil and open swamps, near Williamsburg Oct , 1920, Sept 17, 1921 3198, 4393

CIRSIUM LANCEOLATUM (L) Hill In a pasture, south of Williamsburg July 5, 1921 3949

CIRSIUM SPINOSISSIMUM (Walt) Scop Moist sandy roadside, north of Williamsburg June 6, 1920 2665

COREOPSIS VERTICILLATA L In dry acid soil of thin woods, near Williamsburg June 15, and July 23, 1921 3768, 4101

ECLIPTA ALBA (L) Hassk Marshes along Queen's Creek, north of Williamsburg Aug , 1921

ELEPHANTOPUS CAROLINIANUS Willd Dry ravines, around Williamsburg Frequent Aug 25, 1921 4341

ELEPHANTOPUS NUDATUS Gray Dry oak woods, near Williamsburg Sept 19, 1920 3073

ELEPHANTOPUS TOMENTOSUS L Open situations in pine-oak woods, throughout the region Sept 18, 1920 3034

ERECHTITES HIERACIFOLIA (L) Raf Moist soil of cut-over woods, west of Williamsburg July–Sept, 1921 4354

ERIGERON ANNUUS (L) Pers Weed in Williamsburg Nov , 1920 3244

ERIGERON PHILADELPHICUS L Fields, throughout Common Flowering March 21, 1921

ERIGERON PULCHELLUS Michx Scattered colonies in oak woods, around Williamsburg April 29, 1920 2520

ERIGERON RAMOSUS (Walt) B S P Shaded ravines, around Williamsburg June 15, 1920 2707

EUPATORIUM ALBUM L Dry woods, throughout the region Aug and Sept , 1921 4380

EUPATORIUM CAPILLIFOLIUM (Lam) Small Abandoned fields, Williamsburg Low ground by streams and ponds, throughout the Peninsula Oct , 1920 and 1921 3168, 4648

EUPATORIUM COELESTINUM L Low ground in open situations, Williamsburg Common Oct 3, 1920 3138

EUPATORIUM HYSSOPIFOLIUM L Hedgerow, near Williamsburg Oct 19, 1920 3190

EUPATORIUM PERFOLIATUM L Swampy flood-plain, near Williamsburg Oct 12, 1921 4589

EUPATORIUM PUBESCENS Muhl Sphagnum-magnolia swamp, west of Williamsburg Aug 25, 1921 4316

EUPATORIUM PURPUREUM L Moist low ground of roadsides and woods Aug, 1921

EUPATORIUM ROTUNDIFOLIUM L Flat pine woods, near Williamsburg Sept 25, 1920 3083

EUPATORIUM SEROTINUM Michx Swampy ground, near Williamsburg Oct 20, 1920 3208

EUPATORIUM URTICAEFOLIUM Reichard Moist rich woods, around Williamsburg Sept, 1921 4359, 4440

EUPATORIUM VERBENAEFOLIUM Michx Edge of sandy swamp, west of Williamsburg Sept 9, 1921 4370

EUPATORIUM VERTICILLATUM Lam Damp sandy soil at edge of pine woods and marsh, Queen's Creek, north of Williamsburg Aug 22, 1921 4298

GALINSOGA ARISTULATA Bicknell Weed in gardens, Williamsburg Oct, 1920 3236

GNAPHALIUM OBTUSIFOLIUM L Edge of cut-over woods west of Williamsburg Oct 17, 1920 3172

GNAPHALIUM OBTUSIFOLIUM L var MICRADENIUM Weatherby Dry roadside, near Williamsburg Sept 9, 1921 4351

GNAPHALIUM PURPUREUM L Weed in arable field, Williamsburg May, 1920 and 1921 2571, 3641

GRINDELIA SQUARROSA (Pursh) Dunal Sandy soil of an orchard, mouth of Carter's Creek at York River Single plant observed Aug 20, 1921 4265

HELENIUM AUTUMNALE L Moist ground of flood-plains, throughout In flower Aug 27, 1921 4325

HELENIUM TENUIFOLIUM Nutt Dry sandy soil, streets of Norfolk Sept 30, 1921 4511

HELIANTHUS ATRORUBENS L Opening on top of slope in oak woods, near Williamsburg Sept 19, 1920 3036

HELIANTHUS DIVARICATUS L Sandy roadside soil, at Ewell, July 2, 1921 Roadside near Williamsburg July 23, 1921 3903, 4107

HELIANTHUS SCHWEINITZII T & G Sphagnum-magnolia swamp, south of Ewell Sept 27, 1921 4474

HELIANTHUS STRUMOSUS L Flood-plains of streams and rivers throughout Flowering in Aug, 1921 4243, 4334

HELIANTHUS TRACHELIIFOLIUS Mill Sphagnum-magnolia swamp, west of Williamsburg Sept 27, 1921 4476

HELIANTHUS TUBEROSUS L Rich peaty soil of roadside, near Norfolk 4544

HELIOPSIS HELIANTHOIDES (L) Sweet Dry wooded slope, southeast of Williamsburg Sept 24, 1921 4462

HIERACIUM GRONOVII L Dry pine woods and sandy fields, around Williamsburg Aug , 1920 and 1921 3076, 4232

HIERACIUM MARIANUM Willd Roadside, Camp Wallace July 5, 1921 3944

HIERACIUM VENOSUM L Open hardwood slope, near Williamsburg May 20, 1920 2596

HYPOCHAERIS RADICATA L Shaded bank along roadside, near Chisel's Run, James City Co July 2, 1921 3897

IVA ORARIA Bartlett Tidal marshes of York River Oct , 1921 4569

KRIGIA VIRGINICA (L) Willd Dry uplands and sandy fields, James City Co April 16, 1921 3426

KUHNIA EUPATORIOIDES L Thin dry pine woods, near Williamsburg Sept 9, 1921 4349

LACTUCA CANADENSIS L Cultivated ground, Williamsburg Oct , 1920 3243

LACTUCA FLORIDANA (L) Gaertn Moist hardwood banks, James City Co Sept , 1921 and Aug , 1920 3026, 4253

LACTUCA SCARIOLA L Ballast along C & O Railroad, west of Williamsburg July 23, 1921 4090

LIATRIS GRAMINIFOLIA (Walt) Willd var DUBIA Gray Opening in flat pine woods, west of Williamsburg Sept 25, 1920 3107

LIATRIS SQUARROSA Willd Dry sandy soil, just west of Elko, Henrico Co Aug 6, 1921 4195

MIKANIA SCANDENS (L) Willd Tidal marsh of James River, near Jamestown Swampy flood-plain, near Williamsburg July and Sept , 1921 3976, 3035

PARTHENIUM INTEGRIFOLIUM L Dry sandy soil, near Williamsburg June 16, 1921 3762

PLUCHEA CAMPHORATA (L) DC Tidal marshes of York River and tributaries August, 1921 4268, 4292

POLYMNIA UVEDALIA L Rich heavy calcareous soil, around Williamsburg Frequent Aug 11, 1921 4219

PRENANTHES SERPENTARIA Pursh Sandy soil along railway and in woods, throughout the region Sept and Oct, 1921 3166, 4553

PRENANTHES VIRGATA Michx Sphagnum swamp west of Williamsburg Oct 16, 1921 4633

PYRRHOPAPPUS CAROLINIANUS (Walt) DC Dry roadsides, James City Co June and July, 1921 3804, 3931

RUDBECKIA FULGIDA Ait Dry open cut-over woods, near Williamsburg Aug 27, 1921 4347

RUDBECKIA HIRTA L Fields and woods, throughout the Peninsula June and Aug, 1921 3834, 4181

* RUDBECKIA LACINIATA L var HUMILIS Gray Swampy flood-plains and wet thickets, in James City Co End of August to Oct, 1921 4372, 4469, etc

RUDBECKIA TRILOBA L Moist wooded ravine, near Camp Wallace, Aug 18, 1921 4257

SENECIO AUREUS L Widespread throughout, especially in flood-plains of streams March 17, 1921 2521, 3290

SENECIO SMALLII Britt Abundant weed in abandoned ploughed fields, throughout the region April and May 2623, 3570

SENECIO TOMENTOSA Michx General, in dry sterile open soil May, 1920, April, 1921 2542, 3552

SENECIO VULGARIS L In a clover field, near Williamsburg March 31, 1921 3369 One station

SERICOCARPUS ASTEROIDES (L) B S P Openings in pine woods, near Williamsburg June 2683, 3681 Abundant

SERICOCARPUS LINIFOLIUS (L) B S P Sandy soil, on edge of pine woods, near Williamsburg May and June, 1921 3744, 3643 Common

SILPHIUM TRIFOLIATUM L Borders of woods, throughout the region July, 1921 4036

SOLIDAGO ALTISSIMA L Abandoned fields, and edge of marsh along College Creek, Williamsburg Sept and Oct 4439, 3128

SOLIDAGO BICOLOR L Pine slope, near Williamsburg Oct 20, 1920 3202

SOLIDAGO BOOTTII Hook Reverted cultivated field, near Williamsburg Sept 23, 1921 4445

SOLIDAGO CAESIA L Moist woods, throughout Sept and Oct 3042, 3154

SOLIDAGO ERECTA Pursh Dry pine-oak woods, near Williamsburg Sept, 1920 3918, 3064

SOLIDAGO GRAMINIFOLIA (L) Salisb var NUTTALLII (Greene) Fernald Open sandy fields, south of Williamsburg Sept 23, 1921 4437, 4444

SOLIDAGO LATIFOLIA L Rich wooded slopes, around Williamsburg Sept 3152, 4452

SOLIDAGO MINOR (Michx) Fernald Dry open soil, near Williamsburg Sept 17, 1921 4400

SOLIDAGO NEMORALIS Ait Old sandy fields, around Williamsburg Sept 3129, 4435

SOLIDAGO RUGOSA Mill var ASPERA Fernald Sandy flat, among trees on edge of marsh, Queen's Creek, north of Williamsburg Oct 8, 1921 4550

SOLIDAGO SEMPERVIRENS L Salt marshes of Queen's Creek, and along beach at Newport News Sept, 1921 4387, 4507

SOLIDAGO SUAVEOLENS Schoepf Sandy clearing on edge of marsh, Queen's Creek, and in dry pine woods, around Williamsburg Aug and Sept, 1920, 1921 4078, 4239, 3068

SOLIDAGO TENUIFOLIA Pursh Sandy roadsides, west of Williamsburg Oct 19, 1920 3182

SONCHUS ASPER (L) Hill Fields and waste land, Williamsburg Flowering at end of April, 1921

TARAXICUM OFFICINALE Weber Fields and waste land, Williamsburg

TETRAGONOTHECA HELIANTHOIDES L Dry shaded hillside, near Williamsburg June 30, 1921

VERBESINA OCCIDENTALIS (L) Walt Edge of dry woods and in flood-plains, James City Co Aug, 1921 4339

VERBESINA VIRGINICA L Rich shaded slopes, around Williamsburg Aug and Sept 3058, 4328

VERNONIA NOVEBORACENSIS Willd Sandy soil near swamps, York and Henrico counties Aug, 1921 4180, 4262

? VERNONIA TOMENTOSA (Walt) Ell Edge of tidal marsh, Queen's Creek, north of Williamsburg Aug 22, 1921 4299

XANTHIUM AMERICANUM Walt Weed in cultivated fields, Williamsburg Oct, 1920 3231

XANTHIUM CHINENSIS Mill Cultivated field, near Williamsburg Nov 5, 1920 3253

UNIVERSITY OF MICHIGAN

SELECT BIBLIOGRAPHY OF VIRGINIA FLORA

(The arrangement is chronological)

1688 BANISTER, JOHN E catalogo huc transmisso anno 1680 quem composuit Johannes Banister plantarum a seipso in Virginia observatarum In Ray, Historia plantarum, 2 1928–1928 bis Londini, 1688

1693 The Extracts of Four Letters from Mr John Banister to Dr Lister Phil Trans Roy Soc Lond, 17 (March, 1693) 667–672

1739 GRONOVIUS, JOHANNES FREDERICUS Flora virginica, exhibens plantas quas v c Johannes Clayton in Virginia observavit atque collegit Pars prima Lugduni Batavorum, apud C Haak, 1739 Pages 3–128, 3 Pls

1743 —— Pars II, pp 129–206 Lugduni Batavorum, apud C Haak, 1743 (paged continuously with Vol I, which was also re-issued in 1743)

1748 MITCHELL, JOHN Dissertatio brevis de principiis botanicorum et zoölogorum deque novo stabiliendo naturae rerum congruo, cum appendice aliquot generum plantarum recens conditorium Ad virum celeberrimum Petrum Collinsonum ex Virginia transmissa et hujus favore cum D D Christ Jacob Trew communicata Acad Caes Nat Curios, Acta Phys Med, VIII Appendix, pp 187–224

—— Norimbergae, impensis W Schwartzkopfii, 1769 46 pages, 1 Pl.

1799 LATROBE, B H Memoir on the Sand Hills of Cape Henry, in Virginia Trans Am Phil Soc, IV 439–443

1806 BARTON, BENJAMIN SMITH Some Account of Mr John Banister, the Naturalist Phila Med and Phys Journ, 2 (Part II) 134–139

1814 PURSH, FREDERICK Flora Americae Septentrionalis 2 vols., London.

1837 CROOM, H B Sarracenia flava Reported from Southampton Co, Virginia. Ann Lyc N Y, 4 103

1842 Gray, Asa Notes of a Botanical Expedition to the Mountains of North Carolina, etc Am Journ Sci and Arts, 42 1–49

1852 Lesquereux, Leo Torfbildung im grossen Dismal Swamp Zeitschr der deutsche geolog Gesellsch , 4 695–697

1873 Chickering, J W The Flora of the Dismal Swamp Am Nat , 7 521–524

Curtiss, A H Catalogue of the Phanerogams and Vascular Cryptogamous Plants of Canada and the Northeastern Portions of the United States including Virginia and Kentucky Liberty, Va

1875 Leggett, William Henry Plants collected near Mobjack Bay, Va Bull Torr Club, 6 48–49

1877 Chickering, J W A Botanical Trip in Virginia Field and For , 3 1–4

Ward, Lester Frank Timber Trees of the Dismal Swamp Field and For , 3 29–31

—— Glimpses of the Cosmos, II 141 N Y , 1913

1881 —— Guide to the Flora of Washington, D C , and Vicinity (with map) Bull U S Nat Mus , 26 1–264

1884 Ridgeway, Robert Additional Notes on the Native Trees of the Lower Wabash Valley Proc U S Nat Mus , 17 409–442, Pls 10–15 (*Includes twenty-eight species of trees from near Falls Church, Virginia*)

Shriver, Howard Catalogue of Plants in Herbarium of Howard Shriver, Wytheville, Wythe Co , Virginia 31 pages Printed by Spangler & Davis, Philadelphia

1886 Ward, L F Notes on the Flora of Eastern Virginia Bot Gaz , 11 32–38

1889 Michaux, André Portions of the Journal of André Michaux, Botanist, Written during his Travels in the United States and Canada, 1785–1796 (edited by S P Sargent) Proc Am Phil Soc , 26 1–145

1890 Hollick, Arthur On the Autumn Flora of Southeastern Virginia Mem Torr Club, 2 54–56

Shaler, Nathaniel S General Account of the Freshwater Morasses of the United States, with a Description of the Dismal Swamp Region of Virginia and North Carolina (with illustrations and map) Ann Report U S Geol Surv , 10 255–339

Vail, A M Notes on the Spring Flora of Southwestern Virginia Mem Torr Club, 2 27–53

1892 —— Notes on the Flora of Smythe County, Virginia I–V Gard and For , 5 364, 375–376, 388–389, 424, 437–438

1893 SMALL, J K, AND VAIL, A M Report of the Botanical Exploration of Southwestern Virginia during the Season of 1892 Mem Torr Club, 4 93–201

1894 HELLER, AMOS ARTHUR Plants from Virginia New to Gray's Manual Range, with Notes on Other Species Bull Torr Club, 21 21–27

1895 SMALL, J K Shrubs and Trees of the Southern States. Bull Torr Club, 21 15–27, 300–307, 22 43–48, 365–369, 24 169–178, 228–236, 331–339, 487–496 1895–1897

1896 POLLARD, C L Notes on a Trip to the Dismal Swamp Gard and For, 9 462–463

GREENE, E L Critical Notes on Certain Violets Pittonia, 3 33–35

1899 KRAUSS, ERNST HANS LUDVIG Nova Synopsis Ruborum Germaniae et Virginiae Pars I Monographische Beitrage zur Kenntniss der Gattung Rubus ins besondere der Brombeeren Deutschlands und Virginien, I Teil Saarlouis, Selbstverlag, 1899

POLLARD, CHARLES L The Ostrich Fern in Virginia Fern Bull, 7 71

1901 KEARNEY, THOMAS HENRY Report on the Botanical Survey of the Dismal Swamp Region Contrib U S Nat Herb, 5 321–550 (with illustrations, Pls lxv–lxxvii, 2 folding maps)

1903 HARPER, ROLAND MCMILLAN Some Plants of Southeastern Virginia and Central North Carolina Torreya, 3 120–124

HARSHBERGER, JOHN WILLIAM The Forests of the Natural Bridge, Virginia Forest Leaves, 2 42–44

1906 TIDESTROM, IVAR Elysium marianum, Ferns and Fern Allies 56 pages, 7 Pls. Privately printed, Washington, D C (*This work treats of ferns of Maryland and Virginia*)

—— second edition, Washington, D C, 1907–1908 95 pages, 12 Pls Part II, pp 65–95, on "Evergreens" was published in 1908

1909 BARNHART, J H Some American Botanists of Former Days Torreya, 9 241–243 (*Reference to Clayton's explorations*)

1910 HITCHCOCK, ALBERT SPEAR, AND CHASE, AGNES The North American Species of Panicum. Contrib U S Nat Herb, 15 1–396, (with 370 figures)

1911 COVILLE, FREDERICK VERNON The Recent Excursion into the Dismal Swamp Science, N S, 33 871–872 June 2, 1911

TIDESTROM, IVAR Populus virginiana Fouger Rhodora, 13 195–199 1 figure

STEELE, EDWARD STRIEBY New Plants from Eastern United States. Contrib U S Nat. Herb, 13 359–374

1912 CLARK, WILLIAM B, AND MILLER, BENJAMIN L The Physiography and Geology of the Coastal Plain Province of Virginia Va Geol Surv Bull, 4 1-274 (with illustrations, Pls i xviii, folding map)

HOLLICK, CHARLES ARTHUR Some Features of the Dismal Swamp of Virginia Journ N Y Bot Gard, 13 53-56 (with illustrations)

1913 TIDESTROM, IVAR Notes on the Flora of Maryland and Virginia I Rhodora, 15 101-106

1915 SARGENT, C S Three of Clayton's Oaks in the British Museum Rhodora, 17 39-40

ASHE, W W Monograph on the Loblolly or North Carolina Pine N Ca Geol Surv Bull, 24 1-169 (27 Pls)

1916 MURRILL, WILLIAM A Exploration of Apple Orchard Mountain, Virginia Journ N Y Bot Gard, 17 218-221 Dec, 1916

—— A New Paradise for Botanists [Apple Orchard Mt] Torreya, 16 251-257 (with illustrations)

PENNELL, FRANCIS W Notes on Plants of the Southern United States II Bull Torr Club, 43 407-421

1918 BLAKE, S F Notes on the Clayton Herbarium Rhodora, 20 21-28, 48-54, 65-73

GILES, ALBERT W The Country about Camp Lee, Virginia Va Geol Surv Bull, 16 1-40 (with illustrations, Pls i-xviii, folding map)

CARRIER, LYMAN Dr John Mitchell, Naturalist, Cartographer and Historian Ann Rept Am Hist Assn, 1 201-219 1918

MCATEE, WALDO LEE Note on the Plants of Wallop's Island (Accomac Co), Virginia Torreya, 18 70-71

RICKER, P L A Sketch of Botanical Activity in the District of Columbia, II Bibliography Journ Wash Acad Sci, 8 516-521

1919 EWING, CLARE O, AND STANFORD, ERNEST E Botanicals of the Blue Ridge Journ Amer Pharm Assn, 8 16-26 (with illustrations)

HITCHCOCK, A S, AND STANDLEY, PAUL C Flora of the District of Columbia and Vicinity Contr U S Nat Herb, 21 1-329 Pls i-xlii

MURRILL, W A The Natural History of Staunton, Virginia 216 pages, 4 Pls W A Murrill, New York City, 1919

1920 YOUNG, J P Some Virginia Ferns Am Fern Journ, 10 27 ff

1921 GRIMES, EARL JEROME A New Station for Pogonia affinis. Rhodora, 23 195-197

1922 FERNALD, M. L., AND WEATHERBY, C. A. Varieties of Geum canadense. Rhodora, 24: 47–50.

GRIMES, E. J. Some Plants of the Virginia Coastal Plain. Rhodora, 24: 148–152.

1923 BLAKE, S. F. Two Mediterranean Clovers New to the United States. Science, 57: 209.

WEATHERBY, C. A. Critical Plants of Atlantic North America. Rhodora, 25: 17–23.

AN ANNOTATED LIST OF THE HIGHER PLANTS OF THE REGION OF DOUGLAS LAKE, MICHIGAN *

F C GATES
Kansas State Agricultural College
AND
J H EHLERS
University of Michigan

INTRODUCTION

THIS list of species of ferns and seed-plants is based upon the work at the University of Michigan Biological Station, situated on Douglas Lake, Cheboygan County, Michigan The list was started by F M Loew in 1909 and 1910, when somewhat fewer than one hundred and fifty species were listed In 1911, during a survey of the region for the Michigan Biological and Geological Survey, F C Gates brought the list up to about five hundred and thirty species It was published in the *Fourteenth Report of the Michigan Academy of Science* In 1912, while making a herbarium of the region for the Biological Station, Miss Maude Robertson further extended the recorded flora, bringing it up to six hundred and fifty species From this time until 1915 the list was in charge of Dr H A Gleason In 1915 it reverted to F C Gates Since 1916 responsibility for revisions and extensions has been shared by the authors of this paper, which will take the place, in a much more detailed form, of the list of species that would otherwise have accompanied a forthcoming paper on the vegetation of the Douglas Lake region by F C Gates

* Contribution No 221 from the Botanical Laboratory of the Kansas State Agricultural College and Paper No 203 from the Department of Botany of the University of Michigan

The Station herbarium, started in 1912 and continued to date, has been in charge of J H Ehlers since 1916 It is the basis of the flora of the region The present list, however, takes account of several sources of information that have been accessible to the authors, including all papers that have dealt exclusively or in part with the systematic botany of the region Attention should be called here to the detailed representation of the flora of Emmet County in the private herbarium of C W Fallass of Petoskey, Michigan

In addition to the persons mentioned above, others who have made contributions to the Douglas Lake flora are L H Barnum, R M Holman, G E Nichols, W E Praeger, G A Spots, G L Linker, Earl E Lambert, Mrs Charles C Deam, Dorothy J Cashen, Ella M Clark and C O Erlanson

The genus Carex, by far the largest genus of vascular plants in the region, has been thoroughly studied by Mrs Lois Smith Ehlers To her the authors are indebted for careful work in the thorough presentation of the Carex-flora

The basis of the present list is in general Britton and Brown's *Illustrated Flora of the Northern States and Canada*, second edition, although we are not in sympathy with the splitting of genera that is responsible for much of the unfamiliar nomenclature in this work Wherever different, the names as given in Gray's *Manual*, seventh edition, are cited For the grasses, Hitchcock's *Genera of Grasses* (*Bulletin No 772, U S Dept of Agr*) is used, and in certain other cases, for instance, in the genus Carex, later work than either of the two manuals cited above is utilized Where varieties are recognized in Gray's *Manual*, indication of that fact is made in this list The names, arrangement and numbers of families are those of the system developed by Bessey The annotations, while primarily made by Gates in connection with ecological work, also reflect throughout the list the experience of both authors, and further, in the case of the ferns, that of G E Nichols In the case of the genus Carex especial acknowledgment has been made of the observations of Mrs L S Ehlers

Of the various collections that have been made in the region,

the more extensive have been deposited in the Herbarium of the University of Michigan, the Herbarium of Yale University and the Gray Herbarium, by J H Ehlers, the herbaria of Carthage College, Brooklyn Botanic Garden, University of Illinois and Kansas State Agricultural College, by F C Gates, and the Herbarium of the University of Kentucky, by F T McFarland

STATISTICS OF THE FLORA

The flora is prevailingly of a northern type A statistical summary showing the relative representation of the plant families is shown in the accompanying table

TABLE OF SPECIES

Families	Douglas Lake Region Proper	Emmet County	Cheboygan County	Total in This List
Phylum 9 PTERIDOPHYTA				
1 Ophioglossaceae	8	2	8	8
3 Isoetaceae	2	0	2	2
4 Osmundaceae	3	3	3	3
11 Polypodiaceae	17	12	17	17
Phylum 10 CALAMOPHYTA				
2 Equisetaceae	10	10	10	10
Phylum 11 LEPIDOPHYTA				
1 Lycopodiaceae		4		5
3 Selaginellaceae		2		3
Phylum 13 STROBILOPHYTA				
3, 5, 6 Pinaceae	10	11	10	11
9 Taxaceae	1	1	1	1

TABLE OF SPECIES — *Continued*

	Families	Douglas Lake Region Proper	Emmet County	Cheboygan County	Total in This List
	Phylum 14 ANTHOPHYTA				
1	Alismataceae	4	3	4	5
4	Scheuchzeriaceae	2	2	2	3
5	Typhaceae	1	1	1	1
6	Sparganiaceae	6	6	6	8
9	Potamogetonaceae	14	10	14	14
10	Liliaceae	20	19	18	22
18	Juncaceae	11	12	10	13
19	Eriocaulonaceae	1	0	1	1
22	Naiadaceae	1	0	1	1
24	Araceae	4	2	4	4
25	Lemnaceae	2	1	2	2
30	Cyperaceae	102	86	102	112
	(Carex)	(77)	(65)	(76)	(85)
31	Poaceae	78	75	78	91
32	Hydrocharitaceae	3	4	3	4
35	Iridaceae	1	3	1	3
45	Orchidaceae	32	28	33	34
60	Ranunculaceae	24	21	24	25
62	Berberidaceae	2	1	2	2
67	Ceratophyllaceae	1	0	1	1
71	Malvaceae	4	3	4	4
76	Tiliaceae	1	1	1	1
79	Ulmaceae	1	1	1	1
81	Urticaceae	3	3	3	5
82	Sarraceniaceae	1	1	1	1
84	Geraniaceae	2	1	2	2
85	Oxalidaceae	1	1	1	1
87	Balsaminaceae	2	2	2	2
89	Linaceae	1	1	1	1
101	Polygalaceae	1	1	2	2
104	Euphorbiaceae	7	7	4	8
105	Callitrichaceae	1	1	0	1
107	Cistaceae	1	1	1	1
108	Hypericaceae	6	4	6	8
118	Violaceae	11	10	11	11
126	Papaveraceae	3	3	1	3
128	Nymphaeaceae	4	3	4	4
132	Brassicaceae	32	28	30	36

TABLE OF SPECIES — *Continued*

	Families	Douglas Lake Region Proper	Emmet County	Cheboygan County	Total in This List
	Phylum 14 ANTHOPHYTA — *Continued*				
133	Caryophyllaceae	17	15	16	19
135	Portulacaceae	2	3	2	3
136	Aizoaceae	0	1	1	1
140	Salicaceae	20	16	21	21
145	Amaranthaceae	3	4	3	4
146	Chenopodiaceae	5	6	5	6
147	Polygonaceae	21	20	21	23
151	Primulaceae	4	4	4	5
152	Plantaginaceae	3	3	3	3
157	Ericaceae	16	17	16	17
160	Pyrolaceae	8	8	8	8
166	Polemoniaceae	1	0	1	1
167	Convolvulaceae	4	3	4	4
168	Hydrophyllaceae	1	1	0	1
169	Boraginaceae	11	10	10	12
171	Solanaceae	7	5	7	7
172	Oleaceae	4	4	4	4
175	Gentianaceae	4	5	4	6
176	Apocynaceae	3	2	4	4
177	Asclepiadaceae	3	2	4	4
178	Scrophulariaceae	15	17	14	17
179	Bignoniaceae	1	1	0	1
182	Orobanchaceae	2	1	2	2
185	Lentibulariaceae	4	5	4	5
189	Phrymaceae	1	0	1	1
190	Verbenaceae	3	2	3	4
191	Lamiaceae	24	19	24	25
192	Rosaceae	31	29	27	33
193	Malaceae	10	7	10	10
194.	Prunaceae	5	4	5	5
199	Fabaceae	16	13	15	19
200	Saxifragaceae	3	4	2	5
202.	Grossulariaceae	9	8	7	10
203	Crassulaceae	2	2	1	2
204	Droseraceae	2	4	2	4
211	Hamamelidaceae	1	1	1	1
215.	Lythraceae	1	1	1	1
223	Oenotheraceae	11	10	11	12

TABLE OF SPECIES — *Concluded*

Families	Douglas Lake Region Proper	Emmet County	Cheboygan County	Total in This List
Phylum 14 ANTHOPHYTA — *Concluded*				
224 Halorrhagidaceae	3	4	4	4
232 Cucurbitaceae	2	1	2	2
236 Rhamnaceae	1	1	3	3
237 Vitaceae	2	2	2	2
238 Celastraceae	2	0	2	2
240 Aquifoliaceae	2	2	2	2
250 Thymelaeaceae	1	1	1	1
252 Elaeagnaceae	1	1	1	1
254 Santalaceae	2	2	2	2
258 Loranthaceae	1	1	1	1
262 Aceraceae	6	6	6	6
268 Anacardiaceae	3	3	3	3
269 Juglandaceae	2	2	2	2
270 Betulaceae	7	7	7	7
271 Fagaceae	4	5	5	5
272 Myricaceae	2	1	2	2
275 Araliaceae	3	3	3	3
276 Apiaceae	14	12	12	15
277 Cornaceae	6	7	7	7
278 Rubiaceae	10	7	10	11
279 Caprifoliaceae	14	14	13	14
281 Valerianaceae	1	1	1	2
283 Campanulaceae	8	6	10	10
287 Helianthaceae	15	11	13	17
288 Ambrosiaceae	3	5	3	5
289 Heleniaceae	1	1	1	1
292 Inulaceae	9	7	9	9
293 Asteraceae	26	26	27	30
295 Eupatoriaceae	3	3	4	4
296 Anthemidaceae	12	10	9	14
297 Senecionidaceae	4	4	4	4
298. Carduaceae	5	6	6	7
300 Lactucaceae	20	15	20	20
(287–300 "Compositae")	(98)	(88)	(96)	(111)

SUMMARY BY PHYLA

	Families	Douglas Lake Region Proper	Emmet County	Cheboygan County	Total in This County
9	Pteridophyta	30	17	30	30
10	Calamophyta	10	10	10	10
11	Lepidophyta	6	6	7	8
13	Strobilophyta	11	12	11	12
14	Anthophyta	864	780	847	966
	Monocotyledoneae	(282)	(252)	(280)	(318)
	Dicotyledoneae-Axiflorae	(296)	(268)	(288)	(328)
	Dicotyledoneae-Calyciflorae	(286)	(260)	(279)	(320)
	Totals	921	825	905	1026

LIST OF SPECIES

In the list attention has been called definitely to the occurrence of the plants in Emmet and Cheboygan counties by the capital letter "E" or "C," or by both at the end of the first line for each species Most of the records, however, pertain to Cheboygan County In cases where a species has not been found by the authors in the comparatively small part of Emmet County included in the Douglas Lake region, but is recorded by Fallass and Swift in an unpublished list of Emmet County plants, an asterisk follows the "E" (E*)

Phylum 9 PTERIDOPHYTA (THE FERNS)

1 OPHIOGLOSSACEAE (Adder's Tongue Family)

OPHIOGLOSSUM VULGATUM L Adder's Tongue C
In a clearing in Reese's Bog in 1915, and in an overgrown clearing northwest of Burt Lake in 1922

BOTRYCHIUM SIMPLEX E Hitchcock C
Infrequent in beech-maple woods along Burt Lake and in the aspens in North Fishtail Bay

BOTRYCHIUM ONONDAGENSE Underw C
Found once in the North Fishtail Bay region

BOTRYCHIUM NEGLECTUM Wood (*Botrychium ramosum* (Roth) Aschers) C
Rare in beech-maple woods

BOTRYCHIUM MATRICARIAE (Schrank) Spreng (*B ternatum rutaefolium* (A Br) D C Eaton) C
In a beech-maple woods Quick, 1911

BOTRYCHIUM SILAIFOLIUM Presl (*B ternatum intermedium* D C Eaton) E * C
Occasional in thickets bordering boggy areas, East Point, etc

BOTRYCHIUM LANCEOLATUM (S G Gmel) Angs (*B lanceolatum angustisegmentum* Pease & Moore) C
In the Burt Lake beech-maple forest

BOTRYCHIUM VIRGINIANUM (L) Sw E C
Common in both beech-maple woods and cedar bogs Cecil

3 ISOETACEAE (Quillwort Family)

ISOETES MACROSPORA Durieu C
In Vincent Lake

ISOETES BRAUNII Durieu (*I echinospora Braunii* (Dur) Engelm) C
A few plants off Hook Point in Douglas Lake

4 OSMUNDACEAE (Royal Fern Family)

OSMUNDA REGALIS L Royal Fern E C
In boggy or wet ground in various shrub associations and in openings in tree associations — not critical in association Cecil

OSMUNDA CINNAMOMEA L Cinnamon Fern E C
Locally in cedar bogs and boggy places in beech-maple forests and various shrub associations, especially in the Salix-Cornus thickets Cecil

OSMUNDA CLAYTONIANA L E * C
Local in beech-maple woods or occasionally in bogs

11 POLYPODIACEAE (Fern Family)

ONOCLEA SENSIBILIS L Sensitive Fern E C
In wet ground associations, common Cecil

MATTEUCCIA STRUTHIOPTERIS (L) Todaro (*Onoclea Struthiopteris* (L) Hoffm Ostrich Fern E C
Locally abundant in wet places in the better soils, north and west of Douglas Lake Cecil

FILIX BULBIFERA (L) Underw (*Cystopteris bulbifera* (L) Bernh) E C
Locally abundant in soggy ground, in ravines, in beech-maple forests, and along streams in woods

FILIX FRAGILIS (L) Underw (*Cystopteris fragilis* (L) Bernh) C
Local in beech-maple forests, rare

DRYOPTERIS NOVEBORACENSIS (L) A Gray (*Aspidium noveboracense* (L) Sw) C
Rare in cedar bogs (F Smith)

DRYOPTERIS THELYPTERIS (L) A Gray (*Aspidium Thelypteris* (L) Sw) Marsh Shield Fern E C
In boggy ground associations, but characteristic and frequently representative of the Iris association Very common Cecil

DRYOPTERIS CRISTATA (L) A Gray (*Aspidium cristatum* (L) Sw) E C
In wet woods, frequent

DRYOPTERIS GOLDIANA (Hook) A Gray (*Aspidium Goldianum* Hook) C
In beech-maple woods on the west side of Burt Lake, rather rare

DRYOPTERIS SPINULOSA (Muell) Kuntze (*Aspidium spinulosm* (O F Müller) Sw) Shield Fern E C
Fairly common in the beech-maple association and in cedar bogs

DRYOPTERIS INTERMEDIA (Muhl) Gray (*Aspidium spinulosum*

intermedium (Muhl) D C Eaton) C
Rather common, especially in the beech-maple forests

DRYOPTERIS PHEGOPTERIS (L) C Chr (*Phegopteris polypodioides* Fée) Beech Fern C
In the beech-maple forest, but rare North Fishtail and Burt Lake hardwoods in 1914 (Frank Smith), Reese's in 1918 (Praeger)

DRYOPTERIS DRYOPTERIS (L) Britton (*Phegopteris Dryopteris* (L) Fée) Oak Fern E C
Locally abundant in cedar bogs and the beech-maple forest Cecil

ATHYRIUM THELYPTEROIDES (Michx) Desv (*Asplenium acrostichoides* Sw) E * C
A plant found in the Mud Lake beech-maple forest, in 1921 (E Walker)

ATHYRIUM FILIX-FOEMINA (L) Roth (*Asplenium filix-femina* (L) Bernh) Lady Fern E C
Common in wet or moist woods Cecil

ADIANTUM PEDATUM L Maiden-hair Fern E C
Locally abundant in the beech-maple woods west of Pellston and along the west shore of Burt Lake, often maintaining itself in the open for several years after the woods are cut N Fishtail and Mud Lake areas

PTERIDIUM AQUILINUM (L) Kuhn (*Pteris aquilina* L) Bracken Fern E C
A low dominant, very abundant in the aspen association, present in several others Cecil

POLYPODIUM VULGARE L Polypody C
Locally abundant on an eroding bluff west of Grapevine Point The only station

Phylum 10 CALAMOPHYTA

2 EQUISETACEAE (Horsetail Family)

EQUISETUM ARVENSE L Horsetail E C
Occasional on dunes along Douglas Lake and along roads, in moist sandy soil Becoming more common Cecil

EQUISETUM SYLVATICUM L Wood Horsetail E C
Fairly common in cedar bogs and in thickets following the burning of such bogs

EQUISETUM PALUSTRE L Marsh Horsetail E * C
Occasional on wet shores of Douglas and Burt lakes

EQUISETUM LITTORALE Kuhlewein Shore Horsetail E C
In the gorge and in Reese's Bog along Burt Lake

EQUISETUM FLUVIATILE L Swamp Horsetail E C
Locally very abundant in water of lakes, streams, ditches, etc Cecil

EQUISETUM ROBUSTUM A Br (*E hyemale robustum* (A Br) A A Eaton) Stout Scouring Rush E C
Locally abundant, as in the gorge

EQUISETUM HYEMALE L Common Scouring Rush E C
In ravines in the beech-maple forest, occasional

EQUISETUM HYEMALE var INTERMEDIUM A A Eaton C
Collected in 1911 (Margaretta Packer)

EQUISETUM LAEVIGATUM A Br Smooth Scouring Rush E * C
Occasional in wet ground near Maple River, Pine Point

EQUISETUM VARIEGATUM Schleich E C
Frequent to locally abundant, Pine Point, Sedge Point Var *Nelsoni* A A Eaton is occasional in Big Stone Bay, Ingleside and in a marsh in the jack pine plains Var *Jesupi* A A Eaton found at Fontinalis Run, 1923 (C O Erlanson)

EQUISETUM SCIRPOIDES Michx E C
Frequent in cedar bogs and along sandy, wooded bluffs

Phylum 11 LEPIDOPHYTA

1 LYCOPODIACEAE (Club-Moss Family)

LYCOPODIUM LUCIDULUM Michx E C
Fairly common in the beech-maple forest

LYCOPODIUM OBSCURUM L (*L obscurum* var *dendroideum* (Michx) D C Eaton) Ground Pine E C
Frequent in the beech-maple forest and in the gorge Cecil

LYCOPODIUM ANNOTINUM L E C
Occasional in the beech-maple forest and in cedar bogs Big Stone Bay

LYCOPODIUM CLAVATUM L E C
Frequent in wooded areas, cedar bogs and the aspens, becoming more common Big Stone Bay

LYCOPODIUM TRISTACHYUM Pursh C
Locally abundant in pine land aspens, spreading

3 SELAGINELLACEAE (Selaginella Family)

SELAGINELLA RUPESTRIS (L) Spring C
Jack pine plains south of Burt Lake

SELAGINELLA SELAGINOIDES (L) Link E
Low ground on Temperance Point and in Cecil Bay

SELAGINELLA APUS (L) Spring E C
Low ground near Cecil, Temperance Point and near the base of a bluff on Colonial Point

Phylum 13 STROBILOPHYTA (Conifers)

3, 5, 6 PINACEAE (including ABIETACEAE, THUYOPSIDACEAE and JUNIPERACEAE of Bessey's list)

PINUS STROBUS L White Pine E C
Formerly extensively dominating an association, now a few trees remain as relicts, apparently in several associations The abundant seedlings and small trees indicate that it may again take possession of the sandy types of upland soil Occasional also in the beech-maple forest and less frequently in the cedar bogs A fine tree in original stands, none of which are now present Cecil

PINUS RESINOSA Ait Red Pine, Norway Pine E C
Formerly a dominant tree in the pine association, now represented in the aspens and other associations by a few old trees and in places by many seedlings and young trees Becoming rapidly more abundant each year Cecil

PINUS BANKSIANA Lamb Jack Pine E C
A very few old trees in the aspens and seedlings invading the aspens in the area east of Pellston The characteristic tree of the barrens south of Burt Lake Cecil

LARIX LARICINA (Du Roi) Koch Tamarack Larch E C
A dominant tree in the Larix association, normally in bogs, but also on the upland near Lake Michigan and a little west of Lancaster Lake Abundant as a relict in cedar bogs The depredations of the saw-fly larvae have materially aided in suppressing tamarack bogs in favor of spruce or cedar bogs in a much shorter time than normal Cecil

PICEA CANADENSIS (Mill) B S P White Spruce E C
A dominant tree in the Picea-Abies association, but also sparingly in cedar bogs Cecil

PICEA MARIANA (Mill) B S P Black Spruce E C
An abundant tree in tamarack and cedar bogs Cecil A xerophytic modification occurring in the Chamaedaphne association at Bryant's and the Mud Lake bogs often has witches' brooms, due to the dwarf mistletoe Cecil

TSUGA CANADENSIS (L) Carr Hemlock E C
A dominant tree in the beech-maple forest, either freely interspersed among the other trees or occasionally assembled in hemlock "knolls" or "islands," these especially near streams or lakes Invading the aspens near Douglas Lake just east from Bryant's Some are very large trees, most of which are about 400 to 450 years of age

ABIES BALSAMEA (L) Mill Balsam Fir E C
A dominant tree in the Picea-Abies association, common in cedar bogs and found sparingly in the beech-maple forest Cecil

THUJA OCCIDENTALIS L White Cedar, Arbor Vitae E C
The dominant tree in cedar bogs, a ready invader of genetically lower, wet-ground associations, and to a moderate degree a relict in genetically higher associations, such as the beech-maple forest near lakes or streams Very common, being one of the most abundant trees in the region

At Cecil it frequently grows on dunes, following the heath or starting in a beach pool and keeping pace with a slow accumulation of sand

JUNIPERUS SIBIRICA Burgsd (*J communis depressa* Pursh) Low Juniper E C
Rare in the immediate vicinity of Douglas Lake, a station on the east shore and along the road to Pellston, but abundant in the Cecil and Big Stone Bay regions

JUNIPERUS HORIZONTALIS Moench Creeping Juniper E
Common on dunes in the Big Stone Bay region

9 TAXACEAE (Yew Family)

TAXUS CANADENSIS Marsh Yew, Ground Hemlock E C
Fairly abundant in cedar bogs and hemlock islands, but also in the beech-maple forest especially near lakes Gorge, Fairy Island Cecil

Phylum 14. ANTHOPHYTA (Flowering plants)

1 ALISMATACEAE (Water Plantain Family)

ALISMA SUBCORDATUM Raf (*A plantago-aquatica* L) Water Plantain C
A few plants found in a marsh between Vincent and Munro lakes in 1918

SAGITTARIA CUNEATA Sheldon (A form of *S arifolia* Nutt) C
Occasional, Crooked River, Fontinalis Run, Lancaster Lake

SAGITTARIA LATIFOLIA Willd Arrow-Leaf E C
Alternating with Menyanthes in an association around bog lakes and beach pools Extending out into the lakes in sheltered places Abundant at the mouth of Maple River Forma *gracilis* (Pursh) Robinson is found in Crooked River

SAGITTARIA CRISTATA Engelm (Apparently a form of *S graminea* Michx) E
A small patch in Crooked River near Alanson

SAGITTARIA GRAMINEA Michx E C
Occasional in pools or streams, Sedge Point, Bessey Creek and Crooked River

4 SCHEUCHZERIACEAE (Arrow-Grass Family)

TRIGLOCHIN PALUSTRIS L Marsh Arrow-Grass E
Occasional in the marshy margins of boggy areas at Cecil

TRIGLOCHIN MARITIMA L Arrow-Grass E C
A rare secondary species in the *Carex lasiocarpa* association at Mud Lake — the only station in the immediate area Moderately frequent in marshy and boggy areas at Cecil, and on wet sandy shores of Temperance Point in Big Stone and Sturgeon bays

SCHEUCHZERIA PALUSTRIS L C
Occasional in Sphagnum and Chamaedaphne in the Mud Lake bog and rare in Smith's Bog

5 TYPHACEAE (Cattail Family)

TYPHA LATIFOLIA L Cattail E C
In marshes, at the edges of bogs or roads and in ditches Becoming more abundant each year Forms with the spikes separated as in *Typha angustifolia* are occasionally found Cecil

6 SPARGANIACEAE (Bur-Reed Family)

SPARGANIUM EURYCARPUM Engelm Bur-Reed E * C
In the *Scirpus validus* association at Sedge Point and at the mouth of Bessey Creek, uncommon

SPARGANIUM AMERICANUM Nutt C
Bessey Creek, rare

SPARGANIUM LUCIDUM Fernald and Eames E
In a ditch from West Maple River, west of Pellston

SPARGANIUM SIMPLEX Huds C
In the Menyanthes-Sagittaria association in Bessey Creek and at Fontinalis Run

SPARGANIUM DIVERSIFOLIUM Graebner E C
Occasional in streams

SPARGANIUM ACAULE (Beeby) Rydb (*S diversifolium* var *acaule* (Beeby) Fernald & Eames) E
Crooked River, rare

SPARGANIUM ANGUSTIFOLIUM Michx E * C
In a pool at Hook Point, rare

SPARGANIUM MINIMUM Fries E * C
In the Eleocharis association at Smith's Bog, rare

9 POTAMOGETONACEAE (Pondweed Family)

POTAMOGETON NATANS L Pondweed E C
A dominant species in the Potamogeton association in most of the lakes and streams of the region Cecil

POTAMOGETON AMPLIFOLIUS Tuckerm C
Sedge pool

POTAMOGETON ALPINUS Balbis E C
Occasional, especially in lakes In a slow stream in Big Stone Bay

POTAMOGETON HETEROPHYLLUS Schreb E C
Common Two forms of this species, f *myriophyllus* (Robbins) Morong and f *maximus* Morong, were collected in Douglas Lake in 1911 (Margaretta Packer and Ada K Dietz)

POTAMOGETON LUCENS L E C
A dominant species in the Potamogeton association in the lakes and larger streams of the region Common

POTAMOGETON PRAELONGUS Wulf White-stemmed Pondweed E * C
A dominant species in the Potamogeton association in deep water of Douglas Lake From a small patch off Bryant's in 1911, it has developed considerably and spread to additional stations Specimens 7 to 19 feet in length have been obtained

POTAMOGETON PERFOLIATUS L Clasping-leaved Pondweed (including *P Richardsonii* (Benn) Rydb) E * C

A dominant species in the Potamogeton association Common

POTAMOGETON COMPRESSUS L (*P zosterifolius* Schum) E C

A dominant species in the Potamogeton association Common

POTAMOGETON FOLIOSUS Raf C

Maple River, not common

POTAMOGETON FRIESII Ruprecht E C

Not infrequent in lakes and streams

POTAMOGETON PUSILLUS L C

Lancaster Lake and perhaps elsewhere

POTAMOGETON DIMORPHUS Raf C

Lancaster Lake

POTAMOGETON FILIFORMIS Pers E * C

Not infrequent in lakes and streams

POTAMOGETON PECTINATUS L E * C

A dominant species in the Potamogeton association, especially abundant in streams and over flats Cecil

10 LILIACEAE (Lily Family)

TRIANTHA GLUTINOSA (Michx) Baker (*Tofieldia glutinosa* (Michx) Pers) E

Frequent in the marshy margins of boggy areas at Cecil, and on marshy lake shores in Big Stone and Sturgeon bays

ANTICLEA ELEGANS (Pursh) Rydb (*Zigadenus chloranthus* Richards) E

Occasional in marshes along streams and even on low dunes at Cecil and Big Stone bays Temperance Point

HEMEROCALLIS FULVA L Day Lily C

Cultivated in gardens and found at least once as an escape

ALLIUM TRICOCCUM Ait Wild Onion E C

Occasional in beech-maple forests, especially those along Burt Lake and west of Pellston

LILIUM PHILADELPHICUM L E C

Infrequent along roads and in cedar bogs

LILIUM UMBELLATUM Pursh (*Lilium philadelphicum* var *an-*

dinum (Nutt) Ker) Red Lily E C
Locally abundant in cedar bogs and near the margins of woods in the Cecil region Formerly more frequent

LILIUM (intermediate between CANADENSE and SUPERBUM) E C
A few specimens were found in Reese's Bog in 1911 and along a road west of Cecil, but, since the clearing of the localities, they have not again been seen

ERYTHRONIUM AMERICANUM Ker Yellow Adder's-Tongue E
In the beech-maple forests west of Pellston

ERYTHRONIUM ALBIDUM Nutt White Adder's-Tongue E
In the beech-maple forests west of Pellston

CLINTONIA BOREALIS (Ait) Raf E C
Common herb in all the tree associations, but most abundant in the cedar and beech-maple woods Cecil

VAGNERA RACEMOSA (L) Morong (*Smilicina racemosa* (L) Desf) E C
Most characteristic of beech-maple woods, but occurring in nearly all tree associations

VAGNERA STELLATA (L) Morong (*Smilicina stellata* (L) Desf) E C
Common in the aspens especially on sandy ridges near lake shores Cecil

VAGNERA TRIFOLIA (L) Morong (*Smilicina trifolia* (L) Desf) E C
Frequent in Chamaedaphne and cedar bogs, especially Reese's, Bryant's and Mud Lake bogs Cecil

UNIFOLIUM CANADENSE (Desf) Greene (*Maianthemum canadense* Desf) E C
A very characteristic herb of beech-maple woods, although abundant also in cedar bogs and aspens and on sandy ridges along the lake

UVULARIA GRANDIFLORA J E Smith Bellwort E C
A fairly common herb in beech-maple woods, especially those along Burt Lake and west of Pellston

STREPTOPUS AMPLEXIFOLIUS (L) DC E C
A characteristic herb of cedar bogs although nowhere common in this region

STREPTOPUS ROSEUS Michx E C
Occasional in the beech-maple forest Cecil
Including *Streptopus longipes* Fernald, which is rather rare in beech-maple woods

POLYGONATUM BIFLORUM (Walt) Ell Solomon's Seal E C
Frequent in beech-maple woods and present in other tree associations Cecil

MEDEOLA VIRGINIANA L Indian Cucumber-root E C
Quite characteristic of beech-maple woods, but found also in cedar bogs

TRILLIUM GRANDIFLORUM (Michx) Salisb Large-flowered Trillium E C
Characteristic of beech-maple woods, but occurring also in cedar bogs and in the aspens Cecil

TRILLIUM CERNUUM L Nodding Trillium C
Rare, in cedar bogs, north of Sunny Strand, Reese's Bog and along Trout Creek

SMILAX HISPIDA Muhl Smilax C
In the beech-maple forest on Colonial Point, 1923 (Erlanson)

18 JUNCACEAE (Rush Family)

JUNCUS EFFUSUS L Rush E C
Occasional especially along roads through cedar bogs, becoming more frequent Cecil

JUNCUS BALTICUS Willd (*Juncus balticus* var *littoralis* Engelm) E C
Dominating a shore association and remaining as a relict in other shore associations, sometimes on dunes, but not common in the immediate vicinity of Douglas Lake Fairly common along Lake Michigan at Cecil Bay and around beach pools in Big Stone Bay

JUNCUS BUFONIUS L Toad Rush E C
Roadsides in low ground in clayey soil both in the open and in beech-maple woods, often locally very abundant Cecil

JUNCUS DUDLEYI Wiegand E C

Wet ground at the head of Burt Lake Big Stone Bay

JUNCUS TENUIS Willd Yard Rush E C

A rather common ruderal especially in the heavier soils

JUNCUS LONGISTYLIS Torr E

Plants from the very low dunes between pools west of Cecil approach most closely to this

JUNCUS ARTICULATUS L E

Along Crooked River

JUNCUS ALPINUS Vill (*J alpinus insignis* Fries) E C

Marshes near Bessey Creek and in the jack-pine plains Big Stone Bay and Temperance Point

JUNCUS NODOSUS L Knotted Rush E C

Roadsides through bogs and margins of beach pools, streams, and lake shores

JUNCUS BRACHYCEPHALUS (Engelm) Buch E C

Frequent in low wet ground

JUNCUS CANADENSIS J Gay C

Vincent Lake and in the Carex mat at Smith's Bog

JUNCUS BREVICAUDATUS (Engelm) Fernald E C

In low wet ground at Douglas Lake, Carp Creek and Cecil

JUNCUS ACUMINATUS Michx E

In a ditch along a road west of Douglas Lake

19 ERIOCAULONACEAE (Pipewort Family)

ERIOCAULON SEPTANGULARE With (*E articulatum* (Huds) Morong) C

Abundant in a single station in the region, the east shore of Vincent Lake, where it carpets the ground below the ice ridge and occasionally extends out into about 20 cm of water

22 NAIADACEAE

NAIAS FLEXILIS (Willd) Rost & Schmidt C

A secondary species in the Potamogeton association

24 ARACEAE (Arum Family)

ARISAEMA TRIPHYLLUM (L) Torr (*Arisaema triphyllum* (L) Schott) Jack-in-the-pulpit E C
Common in the beech-maple forests Cecil

ARISAEMA STEWARDSONII Britton C
A single specimen in Reese's Bog (Ehlers)

CALLA PALUSTRIS L Water Arum C
Known from but two stations in the region — bog woods at Mud Lake and north of Sedge Point

ACORUS CALAMUS L Sweet Flag E C
A few patches in the vicinity of Ingleside Mackinaw City

25 LEMNACEAE (Duckweed Family)

LEMNA TRISULCA L Duckweed C
Occasional with the following in the northwest corner of Douglas Lake and at Fontinalis Run, growing on the bottom

LEMNA MINOR L Lesser Duckweed E C
Occasional in the quiet waters of streams and lakes, most abundant in West Maple River, growing on the surface

30 CYPERACEAE (Sedge Family)

CYPERUS HOUGHTONI Torr (*Cyperus Houghtonii* Torr) C
In 1916 a few small patches in sandy roads, west of the gorge and along the grade Becoming more common and appearing in the aspens in 1922 Jack pine plains

ELEOCHARIS OLIVACEA Torr C
Abundant in a single station, the flocculent mud in the eastern edge of Mud Lake

ELEOCHARIS OVATA (Roth) R & S E * C
In Reese's Bog

ELEOCHARIS PALUSTRIS (L) R & S (including *E palustris vigens* Bailey, in Gray's *Manual*, *E p major* Sonder) E C.
Besides being a dominant species in an aquatic association, it occurs in several of the aquatic and semi-aquatic associations in standing and wave-tossed water Cecil

ELEOCHARIS ACICULARIS (L) R & S E * C

Sandy margins of lakes

ELEOCHARIS TENUIS (Willd) Schultes E * C

In wet ground at East Point

ELEOCHARIS ACUMINATA (Muhl) Nees E C

Dominating in an aquatic association and commonly present in several aquatic and semi-aquatic associations

ERIOPHORUM ALPINUM L (*Scirpus hudsonianus* (*Michx*) Fernald) E C

A few patches in the sphagnum at the west end of Mud Lake Occasional in the marshy margin of boggy areas near Cecil

ERIOPHORUM CALLITHRIX Cham E C

Found in Chamaedaphne bogs at Bryant's, Mud Lake and southeast of Big Stone Bay

ERIOPHORUM TENELLUM Nutt E C

In the Hogback Bog and at Cecil

ERIOPHORUM ANGUSTIFOLIUM Roth Cotton-Grass (*E angustifolium majus* Schultz) C

Occasional in boggy areas, East Point, Hogback Bog

ERIOPHORUM VIRIDICARINATUM (Engelm) Fernald Cotton-Grass E C

Frequent to abundant in openings in cedar bogs

ERIOPHORUM VIRGINICUM L Cotton-Grass E C

In Chamaedaphne and cedar bogs, particularly abundant in Bryant's and Mud Lake bogs Cecil Var *album* Gray found at least once in Reese's Bog

SCIRPUS PAUCIFLORUS Lightf E C

Locally abundant beach-pool species, especially so on the flat at the southern margin of Lancaster Lake Cecil

SCIRPUS SUBTERMINALIS Torr C

A submerged aquatic in Silver Lake in Bryant's Bog and in Crooked River Has not yet been found in flower

SCIRPUS AMERICANUS Pers E C

Dominating an aquatic association and readily persisting as a relict in later associations Cecil

SCIRPUS VALIDUS Vahl Bulrush E C

Dominating an important aquatic association and readily persisting as a relict in later associations, even into thickets In Douglas Lake occurs in water up to 8 feet in depth Abundant Cecil

Scirpus occidentalis (S Wats) Chase E C

In lakes and rivers, Colonial Point, Crooked River

Scirpus heterochaetus Chase C

Patches along Crooked River

Scirpus atrovirens Muhl E C

Frequent in roadside ditches Cecil Including *S georgianus* Harper, found at Fontinalis Run

Scirpus lineatus Michx C

A single clump in a grassy road west of Munro Lake

Scirpus cyperinus (L) Kunth (*S cyperinus* var *pelius* Fernald) E C

In moist-ground associations, especially where the original ground-cover has been disturbed Cecil

Scirpus atrocinctus Fernald E C

Frequent in bogs or marshy areas

Dulichium arundinaceum (L) Britton E C

A common secondary species in the *Carex lasiocarpa* association and occasionally in other bog or aquatic associations Particularly abundant in the second pool at Sedge Point, Nichols' bog and in the Hogback bog In the station last named it replaces the Sphagnum, developing after the Chamaedaphne is locally removed

Rynchospora alba (L) Vahl E C

In Sphagnum in the Mud Lake Bog and in bogs west of Cecil

Rynchospora capillacea Torr E

Occasional in marshy margins of boggy areas west of Cecil The variety *laeviseta* E J Hill is abundant on Temperance Point

Mariscus mariscoides (Muhl) Kuntze (*Cladium mariscoides* (Muhl) Torr) E C

Infrequent, dominating an association on the western shore of Douglas Lake and occasional in bogs elsewhere East Point Cecil.

NOTE — The following list of the species of Carex has been contributed by Mrs Lois Smith Ehlers The determinations, except in a very few cases, have been confirmed by Mr Kenneth K Mackenzie

CAREX GYNOCRATES Wormsk E

In a wet Sphagnum bog just west of Cecil Round Lake, Harbor Point

CAREX CONVOLUTA Mackenzie C

A few clumps on Grapevine Point, Douglas Lake and on Colonial Point, Burt Lake

CAREX VULPINOIDEA Michx E C

Very common in roadside ditches and rather frequent in roadways and clearings in bogs Cecil

CAREX DIANDRA Schrank E C

Forming hummocks at Fontinalis Run, Carp Creek, Mud Lake, and Lancaster Lake Round Lake, Little Traverse Bay

CAREX PRAIREA Dewey (*C diandra* var *ramosa* (Boott) Fern) E C

In an opening in a cedar bog along Carp Creek Little Traverse Bay, Round Lake

CAREX STIPATA Muhl E C

Common in moist places along roads and in bogs

CAREX DISPERMA Dewey (*C tenella* Schk) E C

Abundant in damp woods and in cedar bogs

CAREX TRISPERMA Dewey E C

Common in various types of bogs Var *Billingsii* Knight occurs in Reese's Bog

CAREX CANESCENS L E C

In moist ground, infrequent Big Stone Bay Var *subloliacea* Laestad on a hemlock knoll in the beech-maple forest west of Pellston (F C Gates)

CAREX BRUNNESCENS (Pers) Poir C

In moist thickets

CAREX DEWEYANA Schwein E C.

Common in the beech-maple forest Big Stone Bay

CAREX INTERIOR Bailey (*C scirpoides* Schkuhr) E C

Abundant in wet soil and in bogs in the shade, Cecil,

CAREX STERILIS Willd E C

Bogs, Smith's Bog Cecil, Harbor Point, Little Traverse Bay

CAREX LEERSII Willd (*C stellulata* var *ormantha* Fernald) C

A specimen collected in the open in the Mud Lake Bog (F C Gates) appears to be closest to this species

CAREX CEPHALANTHA (Bailey) Bickn (*C stellulata* var *cephalantha* (Bailey) Fernald) C

In shaded swales

CAREX CRAWFORDII Fernald E C

Open boggy places at the head of Burt Lake Round Lake and Little Traverse Bay Var *vigens* Fernald occurs at the old saw-mill at the head of Burt Lake

CAREX SCOPARIA Schk E * C

Boggy ground at the head of Burt Lake, North Fishtail Bay

CAREX TRIBULOIDES Wahl E * C

In burnt-over boggy areas

CAREX CRISTATELLA Britton (*C cristata* Schwein) E C

An opening in a beech-maple forest on Colonial Point Round Lake

CAREX CRISTATELLA × C BEBBII (*fide* Mackenzie) E

Little Traverse Bay (J H and L S Ehlers)

CAREX PROJECTA Mackenzie (*C tribuloides* var *reducta* Bailey) C

Common in moist places, mostly northward of Douglas Lake and especially in burnt-over boggy areas

CAREX BEBBII Olney E C

Common in moist places in thickets, swales and bogs

CAREX STRAMINEA Willd C

In moist open places in bogs and along ditches

CAREX BREVIOR (Dewey) Mackenzie (*C festucacea* Schk , *C festucacea* var *brevior* (Dewey) Fernald) E C

Not infrequent in the aspens

CAREX ADUSTA Boott C

In the aspens, near Smith's Bog Rare

CAREX AENEA Fernald E C

Not infrequent in the aspens

CAREX FOENEA Willd E * C

Occasional in the aspens

CAREX MERRITT-FERNALDII Mackenzie C

Aspen association just east of Douglas Lake Rare

CAREX DURIFOLIA Bailey (*C Backii* Boott) C

In cut-over beech-maple woods on Grapevine Point and near Camp Davis

CAREX LEPTALEA Wahl E C

Very abundant in bogs, usually with *Carex disperma* and *Carex interior*

CAREX PAUCIFLORA Lightf E C

Frequent in the Chamaedaphne association at Bryant's and the Mud Lake bogs Little Traverse Bay (L S Ehlers)

CAREX COMMUNIS Bailey E C

Common in the aspens on the better soils and in second-growth beech-maple forests Harbor Point

CAREX PENNSYLVANICA Lam E C

In the Ammophila dune on Douglas Lake and south of Burt Lake Big Stone Bay

CAREX LUCORUM Willd (*C pennsylvanica* var *lucorum* (Willd) Fernald) E C

A few patches in the aspens near Jarman's, Grapevine Point and south of Camp Davis

CAREX ALBICANS Willd C

In cut-over beech-maple woods on east side of Burt Lake and frequent on Grapevine Point

CAREX UMBELLATA Schk (including *C rugosperma* Mackenzie) E C

An abundant and very characteristic ground species in the aspens, sometimes forming rings 30 or more feet in diameter

CAREX TONSA (Fernald) Bicknell (*Carex umbellata tonsa* Fernald) C

On a sandy ridge in the aspens south of the Biological Station

CAREX PEDUNCULATA Muhl. E C.

In cut-over beech-maple forests on Grapevine Point Harbor Springs

CAREX CONCINNA R Br E

Moist woods back of Big Stone Bay

CAREX EBURNEA Boott E

Damp woods back of Big Stone Bay and on flats on Temperance Point

CAREX HASSEI Bailey (*C bicolor* All) E C

In an old beach pool on the east side of Douglas Lake Stream-side in Big Stone Bay

CAREX AUREA Nutt E C

A common species in beach pools, roadside ditches, and roads through bogs Cecil

CAREX VAGINATA Tausch E * C

In Reese's Bog, rare Swamp at Conway (Fallass)

CAREX PLANTAGINEA Lam E C

Rare, beech-maple woods near Mud Lake and west of Pellston (F C Gates)

CAREX ALBURSINA Sheldon (*C laxiflora* var *latifolia* Boott) E

Two clumps in a beech-maple forest west of Pellston Station since destroyed

CAREX BLANDA Dewey (*C laxiflora* var *blanda* (Dewey) Boott) E * C

Cut-over beech-maple forest on Grapevine Point

CAREX LAXIFLORA Lam E C

Common in cleared beech-maple areas

CAREX ANCEPS Muhl (*C laxiflora* var *patulifolia* (Dewey) Carey) E C

In second-growth beech-maple forests

CAREX LEPTONERVIA Fernald (*C laxiflora* var *leptonervia* Fernald, *Carex anceps* Muhl) E C

In beech-maple forests along North Fishtail Bay and along Burt Lake

CAREX ORMOSTACHYA Wiegand C

In cut-over beech-maple forests on Grapevine Point

CAREX SHRIVERI Britton (*C granularis* var *Haleana* (Olney) Porter) C

Boggy ground at the head of Burt Lake, roadside ditch along east shore of Burt Lake, and in Reese's clearing

CAREX CRAWEI Dewey E

On a stony beach on Temperance Point, Big Stone Bay, Little Traverse Bay

CAREX GRACILLIMA Schwein E C

In wet thickets, aspens, cedar bogs, etc

CAREX PRASINA Wahl C

Along a road through Reese's Bog, rare (F C Gates)

CAREX ARCTATA Boott E C

Frequent in beech-maple forests, stream banks and beach thickets

CAREX CASTANEA Wahl E C

In damp shady spots in bogs and open thickets, Cecil

CAREX KNIESKERNII Dewey E

Roadside through damp woods back of Big Stone Bay

CAREX CAPILLARIS L (including *C capillaris* var *elongata* Olney) E

In a bog west of Cecil

CAREX SCABRATA Schwein E * C

In and near the gorge, not common, but locally abundant Linker's Spring

CAREX LIMOSA L E C

Abundant in the Mud Lake Bog and found first in Bryant's Bog in 1923 Harbor Point

CAREX PAUPERCULA Michx (including *C paupercula* var *irrigua* Fernald) E C

In shaded wet places, especially frequent in the tree zone of wooded bogs Cecil

CAREX BUXBAUMII Wahl (*C polygama* Schk) E C

In a bog west of Cecil Once collected in the edge of a Sphagnum bog north of Douglas Lake in 1915

CAREX STRICTA Lam E C

Common along marshy shores and ditches Cecil

CAREX STRICTIOR Dewey E C

Opening in cedar bog along Carp Creek (J H Ehlers). Little Traverse Bay, Round Lake

CAREX AQUATILIS var SUBSTRICTA Kukenth E C

Along edges of bogs and streams, Burt Lake, Mud Lake, Cecil and Big Stone bays

CAREX CRINITA Lam E C

Common in moist places, in the shade

CAREX LACUSTRIS Willd (*C riparia* W Curtis) E

A single station in a stream north of Levering (F C Gates)

CAREX LANUGINOSA Michx C

In Reese's Bog at the head of Burt Lake

CAREX LASIOCARPA Ehrh (*C filiformis* L) E C

A dominant species in the *Carex lasiocarpa* bog association, a very efficient mat-former, Smith's, Bryant's, Mud Lake bogs, etc Cecil

CAREX HOUGHTONII Torr E C

Ditch along State Road, three miles east of the Biological Station (station since destroyed) At least two stations in railroad ditches between Pellston and Cecil

CAREX VIRIDULA Michx (*C Oederi* var *pumila* (Cosson and Germain) Fernald) E C

Common on the sandy shores of lakes Cecil

CAREX CRYPTOLEPIS Mackenzie (*C lepidocarpa* Tausch , *C flava elatior* Schlecht) C

Wolff's Bog, East Point bogs, and east side of Lancaster Lake, rare

CAREX CRYPTOLEPIS × FLAVA (*fide* Mackenzie) C

Shore of Lancaster Lake

CAREX FLAVA L E C

Frequent in boggy margins of beach pools and small streams Cecil

CAREX VESICARIA L C

Forming large hummocks in boggy places, east of Smith's Bog, Vestal's Bog

CAREX ROSTRATA Stokes E C

In bogs and in other moist places, common

CAREX TUCKERMANI Dewey E C

In swampy areas near Burt Lake and west of Pellston (stations since destroyed)

CAREX RETRORSA Schwein E C
In moist to wet places, very common

CAREX OLIGOSPERMA Michx E C
A common species in some Sphagnum-Chamaedaphne bogs, Mud Lake Bog, Cecil

CAREX SCHWEINITZII Dewey C
Locally abundant along the banks of Carp Creek

CAREX HYSTRICINA Muhl E C
Quite abundant in boggy ground Cecil

CAREX PSEUDO-CYPERUS L E * C
Occasional in moist places and in bogs, especially in burnt-over areas

CAREX COMOSA Boott E C
Mud Lake Bog Round Lake Bog, near Bay View

CAREX INTUMESCENS Rudge (including *C intumescens* var *Fernaldii* Bailey) E C
Common in moist places in shady areas near streams

CAREX LUPULINA Muhl E * C
Locally abundant in wet thickets The var *pedunculata* Dewey occurs in a boggy area near East Point

31 POACEAE (Grass Family)

(Both for arrangement of genera and nomenclature in this family, A S Hitchcock's *Genera of Grasses of the United States, U S Dept Ag Bull 772*, has been followed)

Special studies in the grasses of the region have been made by J H Ehlers, Dorothy J Cashen and Ella M Clark

BROMUS TECTORUM L Downy Brome Grass E
Rare, on railway ballast near Pellston in 1918 and 1920

BROMUS CILIATUS L Brome Grass, Wood Chess E C
Uncommon, in willow and alder thickets on cut- or burnt-over bogs Cecil

BROMUS PURGANS L (including *B altissimus* Pursh) E
Rare, Temperance Point, 1921

BROMUS INERMIS Leyss Awnless Brome Grass E
Rare as a ruderal in the vicinity of Levering Cecil

BROMUS KALMII A Gray C
Under aspens in jack pine plains south of Burt Lake

BROMUS SECALINUS L Cheat E * C
In saw-dust at an abandoned saw-mill at the head of Burt Lake

FESTUCA OCCIDENTALIS Hook E C
A very few clumps in the aspens near the base-line back of Camp Davis (J H Ehlers in 1917 and later), becoming less frequent Big Stone Bay

FESTUCA OVINA L Sheep's Fescue Grass E C
Occasional in the aspens, especially on pine land in the vicinity of Douglas Lake, becoming more abundant Cecil

FESTUCA ELATIOR L E C
Roadside near Levering and in Riggsville and sandy shore of Maple Bay

FESTUCA NUTANS Willd (*F nutans* Spring) Nodding Fescue Grass E * C
In second-growth woodland on Grapevine Point (J H Ehlers), 1918 and later Colonial Point

PANICULARIA CANADENSIS (Michx) Kuntze (*Glyceria canadensis* (Michx) Trin) Rattlesnake Grass C
A few plants in a roadside ditch near a bog north of North Fishtail (J H Ehlers)

PANICULARIA NERVATA (Willd) Kuntze (*Glyceria nervata* (Willd) Trin) Nerved Mannagrass E C
Abundant in open bogs and in willow-thickets along streams and ditches as well as in most wet-ground associations

PANICULARIA GRANDIS (S Wats) Nash (*Glyceria grandis* Wats) E
In west Maple River and similar places

PANICULARIA BOREALIS Nash (*Glyceria borealis* (Nash) Batchelder) E C
Rather frequent in wet places both in bogs and along streams Especially abundant in a wet area north of the Riggsville bog

POA ANNUA L E C
Sparingly as a ruderal in the better soils.

POA NEMORALIS E * C

Near the head of Bessey Creek, 1921

POA SALTUENSIS Fern & Wieg C

One collection in the aspens in the North Fishtail Bay region, 1920, determined by A S Hitchcock

POA PALUSTRIS L (*P triflora* Gilib in both B and B and Gray) False Red-top E C

Common in open wooded areas, both upland and boggy

POA PRATENSIS L Blue Grass, June Grass E C

A common meadow grass, occurring also in abundance along roads and in the aspens Cecil

POA SYLVESTRIS A Gray Sylvan Spear Grass C

Infrequent to rare in wooded areas Pine Point

POA ALSODES A Gray E * C

Has been found in Reese's Bog

POA COMPRESSA L English Blue-Grass E C

A common ruderal along roads and railroads, frequent in meadows and rather common in the aspens Cecil

ERAGROSTIS CILIANENSIS (All) Link (*E major* Host, *E megastachya* (Koeler) Link) E C

Local in the mill-yard at Pellston, Goodrich Farm

PHRAGMITES PHRAGMITES (L) Karst (*P communis* Trin) Reed-grass E C

Occasional in wet ground in the immediate vicinity of Douglas Lake, East Point and Sedge Point The most abundant plant on "Phragmites Flat" in the west part of Douglas Lake Frequently covered with may-fly exuvia Cecil

DACTYLIS GLOMERATA L Orchard Grass E * C

A ruderal, not common, but becoming more so, gorge

MELICA PURPURASCENS (Torr) Hitchcock (*Avena torreyi* Nash *Melica striata* (Michx) Hitchcock, *Bromelica* Farwell) E C

A characteristic although not abundant species in heavily wooded areas, particularly of the beech-maple forest

MELICA SMITHII (Porter) Vasey (*Avena Smithii* Porter) E

In the beech-maple forest at Levering

AGROPYRON REPENS (L) Beauv Couch-grass E C

Ruderal and edificarian, becoming more abundant On the "grade" west of Bryant's Capturing low dunes under appropriate circumstances Cecil

AGROPYRON SMITHII Rydb Blue-joint E

Occasional clumps along roads and with the preceding on the "grade"

AGROPYRON DASYSTACHYUM (Hook) Vasey (*Agropyron dasystachyum* (Hook) Scribn) E

A characteristic grass on Ammophila dunes along Lake Michigan in Cecil and Big Stone bays

AGROPYRON TENERUM Vasey E * C

Occasional in thickets, on dunes and in Riggsville

TRITICUM AESTIVUM L Wheat E C

Cultivated and sparingly escaped in the vicinity of lumber camps

SECALE CEREALE L Rye E C

Commonly cultivated and frequently as an escape along roads and railroads

ELYMUS VIRGINICUS L E

In a thicket along W Maple River, 1920 (Clark and Cashen)

ELYMUS CANADENSIS L Wild Rye E C

Frequent on low sand-dunes with *Salix longifolia*, on Ammophila dunes, and occasional in the aspens farther from Douglas Lake Cecil

HYSTRIX HYSTRIX (L) Millsp (*Hystrix patula* Moench) Bottle-brush Grass E C

Locally abundant in the beech-maple forest

HORDEUM JUBATUM L Squirrel-tail Grass E C

Occasional in waste places Cecil

TRISETUM MELICOIDEUM (Michx) Scribn (*Trisetum melicoides* (Michx) Vasey var *majus* (Gray) Hitchcock, *Graphephorum melicoideum* (Michx) Beauv) C

Rare, along the shore of Douglas Lake at the Biological Station (Fallass, July 31, 1920)

SPHENOPHOLIS PALLENS (Spreng) Scribn (*S pallens* var *major* (Torr) Scribn) C

A rare secondary species in boggy places in the aspens

AVENA BYZANTINA (*Avena sativa* L) Oats E C
Cultivated, also frequent as a ruderal and on sand-dunes along Douglas Lake

AIRA FLEXUOSA L (*Deschampsia flexuosa* (L) Trin) E C
A few clumps in a pine wood southeast of Big Stone Bay Jack pine plains south of Burt Lake

AIRA CAESPITOSA L (*Deschampsia caespitosa* (L) Beauv E C
On the shore of Lake Michigan in Sturgeon and Cecil bays

DANTHONIA SPICATA (L) Beauv E C
A very common secondary species in the aspens on sandy soil

CALAMAGROSTIS CANADENSIS (Michx) Beauv Blue-joint Grass E C
A common grass, dominating in a meadow association around several of the bogs and lowland areas of the region Quite responsive to marked changes of water-level

CALAMAGROSTIS INEXPANSA A Gray Bog Reed Grass E C
With the preceding in boggy habitats, but much less common Lancaster Lake, Mud Lake, Cecil, south of Burt Lake

CALAMAGROSTIS HYPERBOREA Lange E
Lake shore in Cecil, Big Stone and Sturgeon bays

AMMOPHILA ARENARIA (L) Link Beach Grass E C
Abundant on a single dune in South Fishtail Bay of Douglas Lake Quite common on dunes along Lake Michigan in Cecil and Big Stone bays

CALAMOVILFA LONGIFOLIA (Hook) Hack E
Occasionally dominating dunes in Big Stone Bay

AGROSTIS PALUSTRIS Huds (*A alba* L) Red-top E C
Abundant in meadows, in the aspens, on dunes and on the better soils, when cleared A very common ruderal

AGROSTIS CAPILLARIS L (*A alba* var *vulgaris* With) C
Banks of Bessey Creek Determined by A S Hitchcock

AGROSTIS HYEMALIS (Walt) B S P Hair Grass E C
A common secondary species in the aspens

CINNA LATIFOLIA (Trev) Griseb Wood Reed Grass E C
Occasional in lowland woods along Maple River and less frequently along Bessey Creek and elsewhere

ALOPECURUS GENICULATUS L Marsh Foxtail E C
Locally common in cultivated bog land northwest of Ingleside, Smith's Bog (J H Ehlers, 1920), Vestal's Bog, and in ditches along the road into Cecil

PHLEUM PRATENSE L Timothy E C
Cultivated and freely present in cut-over hardwood land, along roads and in the aspens

MUHLENBERGIA MEXICANA (L) Trin E * C
Roadside west of Burt Lake

MUHLENBERGIA RACEMOSA (Michx) B S P E C
Wet ground in bogs and along streams Mud Lake, Alanson

MUHLENBERGIA UMBROSA Scribn (*M sylvatica* Torr) Drop-seed E C
Locally abundant in open thickets on dunes and fringing ridges around Douglas Lake, also along Maple River and Bessey Creek Cecil

MUHLENBERGIA AMBIGUA Torr (*M foliosa* Trin) E * C
D J Cashen, 1921, and road west of Topinabee, Ehlers

BRACHYELYTRUM ERECTUM (Schreb) Beauv C
Sparingly present in lowland woods along Trout Creek in North Fishtail Bay, becoming more common

MILIUM EFFUSUM L Millet Grass E C
A lax grass occasional in the beech-maple forests, especially along the west side of Burt Lake and west of Pellston

ORYZOPSIS PUNGENS (Torr) Hitchcock Mountain Rice E C
Local in pine land aspens, especially north of Reese's Bog and in North Fishtail area, spreading rapidly in the aspens

ORYZOPSIS ASPERIFOLIA Michx Mountain Rice E C
A common secondary species in the aspens, particularly on the sandier soils

SPARTINA MICHAUXIANA Hitchcock Slough, Cord or Marsh Grass E C
A marsh grass, but in this region mostly at the edge of ice work around Douglas Lake and locally on dunes rather close to water level In one place west of Bryant's on the "grade"

TORRESIA ODORATA (L) Hitchcock (*Hierochloe odorata* (L) Wahlenb *Savastana odorata* (L) Scribn) Vanilla Grass E * C

Locally in Myrica thickets and at the edges of bogs and lowland woods along the shores of Douglas Lake Head of Burt Lake

PHALARIS ARUNDINACEA L Reed Canary Grass E C

Infrequent in the Calamagrostis association near the mouth of Bessey Creek, Maple River and in marshes in Sturgeon Bay

HOMALOCENCHRUS ORYZOIDES (L) Poll (*Leersia oryzoides* (L) Sw) Cut-grass Rice Cut-grass C

An infrequent secondary species in the Carex association in Smith's Bog and in associations along North Fishtail Bay and Grapevine Point and in a ditch at Ingleside

ZIZANIA AQUATICA L Wild Rice E C

An aquatic grass locally abundant in spots in Crooked River

SYNTHERISMA SANGUINALE (L) Dulac (*Digitaria sanguinalis* (L) Scop) Crab Grass E

Locally in the Pellston mill-yard

PANICUM CAPILLARE L Witch Grass, Tumble Weed E C

A tumble weed occurring sparingly along roadsides

PANICUM VIRGATUM L Switch Grass C

A very few plants near the bridge over Carp Creek in the gorge The variety *cubense* Griseb collected by Ehlers in 1920 and 1923 in marshy ground in the jack pine plains south of Burt Lake

PANICUM DEPAUPERATUM Muhl E C

A common secondary species in the aspens

PANICUM LINEARIFOLIUM Scribn C.

A secondary species in the aspens

PANICUM WERNERI Scribn C

In the aspens (Ehlers, 1922)

PANICUM HUACHUCAE Ashe E C.

At Sedge Point and in the aspens On the strand in Big Stone Bay and on low ground on Temperance Point

PANICUM VILLOSISSIMUM Nash E
Wet strand in Sturgeon Bay

PANICUM PRAECOCIUS Hitchc & Chase C
Common on blowing sand on dunes along Douglas Lake

PANICUM IMPLICATUM Scribn E * C
On the beach at Pine Point and Sedge Point

PANICUM MERIDIONALE Ashe E C
A common secondary species in the aspens, especially on sandy ground

PANICUM TENNESSEENSE Ashe C
In the aspens in pine land

PANICUM TSUGETORUM Nash C
Pine Point

PANICUM XANTHOPHYSUM A Gray E C
A common secondary species in the aspens, especially on the sandier soils, becoming abundant

PANICUM LATIFOLIUM L E * C
In a swampy area in the aspen association south of Burt Lake

ECHINOCHLOA CRUSGALLI (L) Beauv Barn-yard Grass E C
A ruderal, occasional also in cultivated ground, not very common Cecil

CHAETOCHLOA LUTESCENS (Weigel) Stuntz (*Setaria glauca* (L) Beauv) Yellow Foxtail E C
Ruderal, uncommon to rare, near Mud Lake, and Munro Lake

CHAETOCHLOA VIRIDIS (L) Scribn (*Setaria viridis* (L) Beauv) Green Foxtail E C
Ruderal, also in cultivated ground Cecil

CHAETOCHLOA ITALICA (L) Scribn (*Setaria italica* (L) Beauv) Millet E C
Found in a burnt-over area in 1919 Cultivated west of Pellston

CENCHRUS PAUCIFLORUS Benth (*C carolinianus* Walt) Sand-bur E * C
Railroad ballast at Indian River

ANDROPOGON SCOPARIUS Michx (*Schizachyrium scoparium*

(Michx) Nash in B & B) Bunchgrass E C
A few clumps in grass land in the vicinity of an abandoned lumber mill west of Cecil Railroad ballast, Mackinaw City Abundant in the jack pine plains south of Burt Lake

ANDROPOGON FURCATUS Muhl E * C
Occasional in the jack pine plains south of Burt Lake

SORGHASTRUM NUTANS (L) Nash Indian Grass C
Common in the jack pine plains south of Burt Lake

ZEA MAYS L Corn E C
Cultivated for silage for the most part, but occasionally a waif along roadsides or more frequently along railroads

32 HYDROCHARITACEAE

PHILOTRIA CANADENSIS (Michx) Britton (*Elodea canadensis* Michx) E
In a stream in Big Stone Bay

PHILOTRIA ANGUSTIFOLIA (Muhl) Britton (*E canadensis* Michx) E C
A secondary species in many aquatic associations, also floating in the open lake

PHILOTRIA NUTTALLII (Planch) Rydb (*Elodea canadensis* Michx) E C
A secondary species in many aquatic associations, also floating in the open lake Silver Lake in Bryant's Bog

VALLISNERIA SPIRALIS L Eel-grass E C
A secondary species in the Potamogeton association, especially in North Fishtail Bay, Bessey Creek and Crooked River

35 IRIDACEAE (Iris Family)

IRIS VERSICOLOR L Iris or Blue Flag E C
Besides characterizing an association it occurs in many of the associations of moist or wet ground, persisting as a relict even in thickets or under trees Cecil

IRIS LACUSTRIS Nutt Lake Dwarf Iris E

Fairly abundant in the Thuja association, both along ridges and in depressions along Lake Michigan between Cecil and Big Stone Bay

SISYRINCHIUM ANGUSTIFOLIUM Mill Blue-eyed Grass E

Rare, in a marsh in Cecil Bay region and on rocky shores, Big Stone Bay

45 ORCHIDACEAE (Orchid Family)

CYPRIPEDIUM REGINAE Walt (*C hirsutum* Mill) Showy Lady's-Slipper E C

Occasional in openings and along pathways in cedar bogs Cecil

CYPRIPEDIUM PARVIFLORUM Salisb (including var *pubescens* (Willd) Knight) Yellow Lady's Slipper E C

Frequent in cedar bogs Cecil

CYPRIPEDIUM ACAULE Ait Stemless Lady's-Slipper E * C

Occasional in pine land aspens, particularly in depressions, becoming more frequent

COELOGLOSSUM BRACTEATUM (Willd) Parl (*Habenaria bracteata* (Willd) R Br) C

Beech-maple forest on Colonial Point, 1922 (Nichols)

GYMNADENIOPSIS CLAVELLATA (Michx) Rydb (*Habenaria clavellata* (Michx) Spreng) E C

Infrequent in cedar bogs Cecil

LIMNORCHIS HYPERBOREA (L) Rydb (*Habenaria hyperborea* (L) R Br) E C

Common and extremely variable in all the wooded bogs Cecil

LIMNORCHIS DILATATA (Pursh) Rydb (*Habenaria dilatata* (Pursh) Gray) E

In a bog at Cecil

LYSIAS ORBICULATA (Pursh) Rydb (*Habenaria orbiculata* (Pursh) Torr) E C

Rare, gorge, beech-maple forests west of Pellston, and southwest of Cecil Stations in North Fishtail region now destroyed

LYSIAS ORBICULATA (Pursh) Rydb (*Habenaria macrophylla* Goldie) E C

Rare, usually in coniferous forests Temperance Point

LYSIELLA OBTUSATA (Pursh) Rydb (*Habenaria obtusata* (Pursh) Richards) E C

Rather common in cedar bogs

BLEPHARIGLOTTIS BLEPHARIGLOTTIS (Willd) Rydb (*Habenaria blephariglottis* (Willd) Torr) White-Fringed Orchis C

Local in the Chamaedaphne association at Bryant's and the Mud Lake bogs

BLEPHARIGLOTTIS LACERA (Michx) Farwell (*Habenaria lacera* (Michx) R Br) C

On *Carex lasiocarpa* mat at Mud Lake, rare

BLEPHARIGLOTTIS LEUCOPHAEA (Nutt) Farwell (*Habenaria leucophaea* (Nutt) Gray) E * C

A few plants in the *Carex lasiocarpa* association at the Mud Lake Bog

BLEPHARIGLOTTIS GRANDIFLORA (Bigel) Rydb (*Habenaria fimbriata* (Ait) R Br) C

A single plant in the bog at Fontinalis Run, 1920

BLEPHARIGLOTTIS PSYCHODES (L) Rydb (*Habenaria psychodes* (L) Sw) Purple-Fringed Orchis E C

Occasional, particularly at the edges of cedar bogs

POGONIA OPHIOGLOSSOIDES (L) Ker E * C

In the *Carex lasiocarpa* mat at the Mud Lake Bog

ARETHUSA BULBOSA L E * C

At Mud Lake Bog and Reese's Bog, rare

LIMODORUM TUBEROSUM L (*Calopogon pulchellus* (Sw) R Br) E * C

A few plants in the Chamaedaphne association at Bryant's Bog, but abundant at the Mud Lake Bog

IBIDIUM STRICTUM (Rydb) House (*Spiranthes Romanzoffiana* Cham) Ladies' Tresses E * C.

Occasional at East Point and at Mud Lake

IBIDIUM CERNUUM (L) House (*Spiranthes cernua* (L) Richard) E * C

At East Point and at Mud Lake

IBIDIUM GRACILE (Bigel) House (*Spiranthes gracilis* (Bigel) Beck) E * C
Swamp in jack pine plains south of Burt Lake

OPHRYS CONVALLARIOIDES (Sw) W F Wight (*Listera convallarioides* (Sw) Torr) Twayblade E * C
Rare, in cedar bogs

OPHRYS CORDATA L (*Listera cordata* (L) R Br) E * C
Rare, in cedar bogs

PERAMIUM OPHIOIDES (Fernald) Rydb (*Epipactis repens* var *ophioides* (Fernald) A A Eaton) Rattlesnake Plantain E C
Rare, in Reese's cedar bog, a hemlock knoll in the gorge and at Cecil

PERAMIUM TESSELATUM (Lodd) Heller (*Epipactis tesselata* (Lodd) A A Eaton) E * C
Colonial Point

PERAMIUM DECIPIENS (Hook) Piper (*Epipactis decipiens* (Hook) Ames) E C
A few plants in beech-maple forests north of Douglas Lake Cecil

PERAMIUM PUBESCENS (Willd) MacM (*Epipactis pubescens* (Willd) A A Eaton) E * C
Occasional in the East Point region and elsewhere

MALAXIS MONOPHYLLA (L) Sw (*Microstylis monophyllos* (L) Lindl) E * C
Rare, Reese's Bog and formerly in the North Fishtail region

LIPARIS LILIIFOLIA (L) L C Rich Twayblade C
Mud Lake Bog

LIPARIS LOESELII (L) L C Rich Twayblade E * C
Rare, Reese's Bog

CORALLORRHIZA CORALLORRHIZA (L) Karst (*C trifida* Chat) Coral-root E C
Occasional in cedar bogs

CORALLORRHIZA MACULATA Raf Coral-root E C
Occasional in woods

CORALLORRHIZA ODONTORRHIZA (Willd) Nutt C
A single plant in the Mud Lake Bog, 1920

CORALLORRHIZA STRIATA Lindl Coral-root E C
Occasional in low spots in the beech-maple forest

60 RANUNCULACEAE (Crowfoot Family)

CALTHA PALUSTRIS L Marsh Marigold E C
In open places along streams through cedar bogs Frequent Cecil

COPTIS TRIFOLIA (L) Salisb Gold-thread E C
An abundant species in cedar bogs, frequent in low places in pine land, and on hemlock knolls in the beech-maple forest Cecil

ACTAEA RUBRA (Ait) Willd Red Baneberry E C
Occasional in cedar bogs Forma *neglecta* (Gillman) Robinson in boggy areas in Cecil and Sturgeon bays

ACTAEA ALBA (L) Mill White Baneberry E C
Fairly frequent in beech-maple forests Cecil

AQUILEGIA CANADENSIS L Columbine E C
Sparingly in cedar bogs and in beech-maple forests Cecil

ANEMONE HUDSONIANA Richards (*A multifida* Poir) Red Anemone E
A characteristic interdunal plant in Big Stone Bay, although not abundant Mackinaw City

ANEMONE CYLINDRICA A Gray E C
Occasional in thickets and open places Cecil

ANEMONE VIRGINIANA L E C
Occasional in open beech-maple country Cecil

ANEMONE CANADENSIS L E C
Common in open parts of cedar bogs, especially along roads, ditches and low places along railroads Cecil

HEPATICA HEPATICA (L) Karst (*H triloba* Chaix) Hepatica E C
Occasional in beech-maple forests and to a limited extent in the aspens

HEPATICA ACUTILOBA DC E * C
Infrequent in the beech-maple forest and in the aspens

RANUNCULUS PURSHII Richards C
Muddy banks of Bessey Creek

RANUNCULUS REPTANS L (*R flammula* var *reptans* (L) Mey) C
Occasional in protected places on the Douglas Lake strand, Grapevine Point, Ingleside, west side, Bryant's, etc Much less frequent than formerly, probably on account of ice work in 1917 and 1918

RANUNCULUS ABORTIVUS L Small-flowered Crowfoot E C
Occasional in wet places, Gorge, Bessey Creek, and Riggsville Bog

RANUNCULUS SCELERATUS L E C
Wet ground, especially vigorous following fire in cedar bogs

RANUNCULUS RECURVATUS Poir Hooked Crowfoot E C
Occasional in cedar bogs, abundant west of Pellston

RANUNCULUS ACRIS L Tall or Meadow Buttercup E C
Frequent and abundant along roads through cedar bogs and in other wet places Cecil

RANUNCULUS PENNSYLVANICUS L f E C
In wet places, willow-thickets, gorge, cedar bogs, etc

RANUNCULUS SEPTENTRIONALIS Poir Swamp or Marsh Buttercup E C
Occasionally abundant in lowland woods and in burnt-over bogs and lowlands

RANUNCULUS HISPIDUS Michx C
In brambles and cedar bogs

BATRACHIUM TRICHOPHYLLUM (Chaix) F Schultz (*Ranunculus aquatilis capillaceus* DC) E * C
In Maple River

BATRACHIUM CIRCINATUM (Sibth) Rchb (*Ranunculus circinatus* Sibth) C
An aquatic herb at the mouths of Carp Creek and a creek entering Lancaster Lake

THALICTRUM DASYCARPUM Fisch & Lall Meadow-rue E C
Occasionally abundant in willow and Myrica thickets and other wet-ground associations

THALICTRUM DIOICUM L Early Meadow-rue E * C
A few stations in beech-maple forests on Grapevine Point and on Colonial Point

CLEMATIS VIRGINIANA L Virgin's Bower E C

Willow-thickets along Maple River, Lancaster Lake and occasional in tree associations on burnt-over bog land Larix bog west of Lancaster Lake, growing high

62 BERBERIDACEAE (Barberry Family)

CAULOPHYLLUM THALICTROIDES (L) Michx Blue Cohosh E C
Occasional in beech-maple forests, especially those along Burt Lake, North Fishtail Bay region

PODOPHYLLUM PELTATUM L May Apple C
A specimen found in a beech-maple forest by B E Quick in 1911, but none have been found since

67 CERATOPHYLLACEAE (Hornwort Family)

CERATOPHYLLUM DEMERSUM L Hornwort C
A secondary species in the Potamogeton association, especially abundant in Bessey Creek

71 MALVACEAE (Mallow Family)

ALTHAEA ROSEA L Hollyhock E C
Cultivated in gardens and occasionally escaping along roads

MALVA ROTUNDIFOLIA L Dwarf Mallow E C
Ruderal and farm-yard weed, especially in heavier soils

MALVA MOSCHATA L Musk Mallow E * C
Escaped from cultivation and now rather frequent and becoming more so along roads in the vicinity of Riggsville and northward Flowers white or pink

ABUTILON ABUTILON (L) Rusby (*A Theophrasti* Medic) Velvet Leaf C
Introduced accidentally in seed in 1917 and cultivated as an ornamental through 1919 in a yard near Mud Lake Not since noted

76 TILIACEAE (Linden Family)

TILIA AMERICANA L Basswood E C
A dominant tree in the beech-maple forest, although not

very abundant Of late years it has been fruiting very much more plentifully than formerly Cecil

79 ULMACEAE (Elm Family)

ULMUS AMERICANA L American or White Elm E C
A few old trees in the wetter parts of beech-maple woods and along the lakes, occasional medium-sized trees in the lowland woods, and seedlings and small trees quite commonly in either open or thicket-covered lowlands At Sedge Point seedlings 8–10 years old are on sand-dunes Cecil

81 URTICACEAE (Nettle Family)

HUMULUS LUPULUS L Hops E * C
Cultivated, but escaped along roads near Munro Lake and in Riggsville

URTICA GRACILIS Ait Nettle E
In an open pasture west of Pellston, 1923 Bay View

URTICASTRUM DIVARICATUM (L) Kuntze (*Laportea canadensis* (L) Gaud) Wood Nettle E
Rare, in beech-maple forests west of Pellston

PILEA PUMILA (L) A Gray Clearweed C
Rather rare In low places along roads through beech-maple forests along Burt Lake and near Munro Lake

BOEHMERIA CYLINDRICA (L) Sw False Nettle C
A few patches along a small stream at the northwest corner of Mud Lake

82 SARRACENIACEAE (Pitcher Plant Family)

SARRACENIA PURPUREA L Pitcher Plant E C
A characteristic species in the Chamaedaphne association in bogs, especially abundant in the Mud Lake and Bryant's bogs Cecil

84 GERANIACEAE (Geranium Family)

GERANIUM ROBERTIANUM L Herb Robert E * C
Occasional in beech-maple forests

GERANIUM BICKNELLII Britton C
Occasional in beech-maple forests

85 OXALIDACEAE (Wood Sorrel Family)

OXALIS STRICTA L Sour Grass E C
A few plants in the mill-yard at Pellston and along the lumber railroad west Also near Mud Lake

87 BALSAMINACEAE (Touch-me-not Family)

IMPATIENS BIFLORA Walt Spotted Touch-me-not E C
Common in and about streams in cedar bogs, hardwoods, and in cultivated land Cecil

IMPATIENS PALLIDA Nutt Pale Touch-me-not E C
Rare, in a small flat in a streamlet in the Burt Lake hardwoods Occasional west of Pellston

89 LINACEAE (Flax Family)

LINUM USITATISSIMUM L Flax E C
Occasional in fields near Munro Lake previous to 1917 Rare in mill-yard at Pellston and at Harbor Springs

101 POLYGALACEAE (Milkwort Family)

POLYGALA POLYGAMA Walt C
On the jack pine plains south of Burt Lake

POLYGALA PAUCIFOLIA Willd Fringed Milkwort E C
Moderately frequent in dune thickets, cedar bogs and in the aspens Cecil

104 EUPHORBIACEAE (Spurge Family)

CHAMAESYCE POLYGONIFOLIA (L) Small. (*Euphorbia polygonifolia* L) Seaside Spurge E
Rare, strand of Lake Michigan at Big Stone Bay

CHAMAESYCE SERPYLLIFOLIA (Pers) Small (*Euphorbia serpyllifolia* Pers) C
Near Ingleside

CHAMAESYCE GLYPTOSPERMA (Engelm) Small (*Euphorbia glyptosperma* Engelm) E C
Occasional in waste places

CHAMAESYCE MACULATA (L) Small (*Euphorbia maculata* L) Milk Purslane or Spurge E C
Occasional on ballast of railroads

CHAMAESYCE RAFINESQUI (Greene) Small (*Euphorbia hirsuta* (Torr) Wiegand) Hairy Spurge E
Pellston

CHAMAESYCE PRESLII (Guss) Arthur (*Euphorbia Preslii* Guss) Upright Spotted Spurge E
Ruderal, locally abundant Lumber yard at Pellston

TITHYMALOPSIS COROLLATA (L) Kl & Garcke (*Euphorbia corollata* L) Flowering Spurge E
Railroad ballast north of Pellston

TITHYMALUS CYPARISSIAS (L) Hill (*Euphorbia cyparissias* L) Cypress Spurge E C
Occasional along roads in the better soils, south of Mud Lake, Ingleside, and Cecil

105 CALLITRICHACEAE (Water Starwort Family)

CALLITRICHE PALUSTRIS L E
In a wet place in a road south of Cecil and along the G R & I Railroad north of Pellston

107 CISTACEAE (Rockrose Family)

CROCANTHEMUM CANADENSE (L) Britton (*Helianthemum canadense* (L ?) Michx) Frostweed E C
In pine land areas, not common, but becoming much more so

108 HYPERICACEAE (GUTTIFERACEAE) (St John's-wort Family)

HYPERICUM ASCYRON L Giant St John's-wort E
Shrub along swales west of Cecil

HYPERICUM KALMIANUM L Kalm's St John's-wort E
Shrub on small dunal ridges along Lake Michigan west of Cecil, Big Stone Bay

HYPERICUM PERFORATUM L Common St John's-wort E * C
Locally abundant in an aspen thicket on pine land near Reese's Bog and of late spreading into Riggsville and elsewhere

HYPERICUM BOREALE (Britton) Bicknell C
Locally abundant, Marl Bay, Wolff's Bog, Nichols' Bog

HYPERICUM MUTILUM L C
Plants from part of Marl Bay are closest to this species

HYPERICUM GYMNANTHUM Engelm & Gray C
Plants from Sedge Point are closest to this species

HYPERICUM MAJUS (A Gray) Britton St John's-wort C
Occasional in beach pools and roadside ditches, East Point, Maple River

TRIADENUM VIRGINICUM (L) Raf (*Hypericum virginicum* L) Marsh St John's-wort E C
Common, in marsh associations such as the Iris, Cladium and Calamagrostis associations Cecil

118 VIOLACEAE (Violet Family)

VIOLA PAPILIONACEA Pursh E C.
Occasional in beech-maple woods

VIOLA CUCULLATA Ait E * C
Along Carp Creek, rare

VIOLA RENIFOLIA A Gray E * C
In cedar bogs

VIOLA BLANDA Willd E * C
From the Burt Lake beech-maple forest

VIOLA PALLENS (Banks) Brainerd E C
Common in cedar bogs

VIOLA ERIOCARPA Schwein (*V scabriuscula* Schwein) Smooth Yellow Violet E C
Common in beech-maple forests

VIOLA PUBESCENS Ait Hairy Yellow Violet E C.
Common in beech-maple forests

VIOLA CANADENSIS L E C
Rather common in cedar bogs and low places in beech-maple woods

VIOLA CONSPERSA Reichenb E C
In a bog near Van, also in Reese's Bog

VIOLA SUBVESTITA Greene (*V arenaria* DC) Sand Violet C
A few patches found in the aspens northeast of Burt Lake in 1911 (F C Gates) Area since severely burnt over and station destroyed

VIOLA TRICOLOR L Pansy E * C
Persisting near an abandoned house north of Douglas Lake

126 PAPAVERACEAE incl FUMARIACEAE (Poppy Family)

BICUCULLA CUCULLARIA (L) Millsp (*Dicentra cucullaria* (L) Bernh) Dutchman's Breeches E
Has been collected only in beech-maple forests west of Pellston, but doubtless is much more common than given credit for, because the plants dry up before activities commence at the Biological Station

BICUCULLA CANADENSIS (Goldie) Millsp (*Dicentra canadensis* (Goldie) Walp) Squirrel Corn E
The statements given for the previous species apply to this also

CAPNOIDES SEMPERVIRENS (L) Borck (*Corydalis sempervirens* (L) Pers) Pink Corydalis E C
In 1916 collected on Pine Point As a fireweed locally abundant west of Bryant's in 1917, but since found only west of Pellston

128 NYMPHAEACEAE (Water Lily Family)

NYMPHAEA ADVENA Soland Yellow Water Lily E C
A dominant species in the Castalia-Nymphaea association and common in other aquatic associations Cecil

CASTALIA ODORATA (Dryand) Woodv & Wood White Water Lily E C

A dominant species in the Castalia-Nymphaea association, more frequent in streams and small lakes than in the larger ones, occurring also in other aquatic associations Cecil

CASTALIA TUBEROSA (Paine) Greene White Water Lily E C
Rare

BRASENIA SCHREBERI Gmel Water Shield C
A single small patch in *Scirpus validus* in Douglas Lake, northwest of the mouth of Bessey Creek

132 BRASSICACEAE (Mustard Family)

BERTEROA INCANA (L) DC E C
About a dozen plants on railroad ballast near Cecil, 1918, and Colonial Point, 1923

ALYSSUM ALYSSOIDES L E
A few plants found in railroad ballast near Pellston in 1918

CAMELINA MICROCARPA Andrz C
A ruderal, two stations north of Douglas Lake

BURSA BURSA-PASTORIS (L) Britten (*Capsella bursa-pastoris* (L) Medic) Shepherd's Purse E C
A weed and ruderal plant

RADICULA OBTUSA (Nutt) Greene C
Rare in low ground along roadsides

RADICULA PALUSTRIS (L) Moench C
Maple bay of Burt Lake

RADICULA HISPIDA (Desv) Britton' (*Radicula palustris* (L) Moench, var *hispida* (Desv) Robinson) E C
Frequent in the Iris association, at the borders of willow-thickets and in a few aquatic associations Cecil

SISYMBRIUM NASTURTIUM-AQUATICUM L (*Radicula nasturtium-aquaticum* (L) Britten and Rendle) Water Cress E C
Carp Creek in the gorge, rare

ARMORACIA ARMORACIA (L) Britton (*Radicula armoracia* (L) Robinson) Horse-radish E * C
Escaped from cultivation along the east side of Burt Lake, Ehlers, 1916

LEPIDIUM CAMPESTRE (L) R Br E C

A few plants found on railroad ballast at Pellston and near Cecil, Ingleside

LEPIDIUM VIRGINICUM L Peppergrass E C
A fairly common ruderal and occasional in the aspens Cecil

THLASPI ARVENSE L Penny Cress E * C
A single plant along the road west of Bryant's, 1921

SOPHIA SOPHIA (L) Britton (*Sisymbrium Sophia* L) E * C
Roadside weed, Colonial Point

SOPHIA INCISA (Engelm) Greene (*Sisymbrium incisum* Engelm) C
Bluff on Colonial Point

CHEIRINIA CHEIRANTHOIDES (L) Link (*Erysimum cheiranthoides* L) E C
A ruderal in roadside ditches and a weed in wet fields in better soils

ERYSIMUM OFFICINALE L (*Sisymbrium officinale* (L) Scop) Hedge Mustard E C
Ruderal and edificarian, railroad ballast, occasional Var *leiocarpum* D C is an uncommon ruderal, Reese's, Ingleside

NORTA ALTISSIMA (L) Britton (*Sisymbrium altissimum* L) Tumble Mustard E * C
A ruderal and weed, very sparingly in the aspens

CONRINGIA ORIENTALIS (L) Dumort Hare's-ear Mustard E
A single collection, mill-yard in Pellston, July 20, 1917 (H A Gleason)

BARBAREA STRICTA Andrz E
Ditch along railroad into Cecil, Carp Lake

ARABIS LYRATA L E
Frequent on dunes in Big Stone Bay

ARABIS GLABRA (L) Bernh Tower Mustard E * C
Common secondary species in the aspens

ARABIS CANADENSIS L Sickle-pod C
Rather rare in aspens, Sedge Point region

ARABIS DRUMMONDII A Gray C
Occasional in the aspens Grapevine Point

ARABIS BRACHYCARPA (T & G) Britton Purple Rock Cress E * C

Frequent in thickets and aspens Increasing in abundance

ARABIS HOLBOELLII Hornem E

A few plants on sand-dunes in Big Stone Bay

CARDAMINE PRATENSIS L Cuckoo Flower E * C

A single plant in a clump of Sphagnum and Chamaedaphne in the Mud Lake Bog, 1920 (Ikenberry and Gates) In moss along a stream in Reese's Bog, 1923 (Ehlers)

CARDAMINE PENNSYLVANICA Muhl E C

Banks of Bessey Creek in 1911 Cecil

SINAPIS ALBA L (*Brassica alba* (L) Boiss) C

Weed near Bryants, 1917 (H A Gleason)

SINAPIS ARVENSIS L (*Brassica arvensis* (L) Kuntze) Charlock E * C

Ruderal and weed, not very common

BRASSICA NIGRA (L) Koch Black Mustard E * C

Occasional as a weed or ruderal

BRASSICA JUNCEA (L) Cosson E C

Occasional in the vicinity of lumber camps Cecil

BRASSICA CAMPESTRIS L (*Brassica rapa* L) Turnip E C

Cultivated and sparingly escaped in the vicinity of lumber camps, N Fishtail Bay, Cecil

DIPLOTAXIS MURALIS (L) DC E C

From a clearing in Riggsville Bog (J H Ehlers) Bay View, Fallass

RAPHANUS RAPHANISTRUM L Wild Radish C

A weed at Ingleside, uncommon

RAPHANUS SATIVUS L Garden Radish E C

Cultivated

CAKILE EDENTULA (Bigel) Hook American Sea Rocket E

Strand of Lake Michigan at Big Stone Bay Not common

133 CARYOPHYLLACEAE (Pink Family)

ALSINE MEDIA L (*Stellaria media* (L) Cyrill) Chickweed E C

Ruderal in low ground, especially along roads through beech-maple forests

ALSINE LONGIFOLIA (Muhl) Britton (*Stellaria longifolia* Muhl)
E C

Occasional in open low places in beech-maple forests, also in tamarack woods northwest of Lancaster Lake

ALSINE BOREALIS (Bigel) Britton (*Stellaria borealis* Bigel) C

Riggsville Bog

CERASTIUM VULGATUM L Mouse-ear Chickweed E C

Along roads through cedar bogs and in similar low places Cecil

CERASTIUM LONGIPEDUNCULATUM Muhl (*C nutans* Raf) E

Railroad ballast at W Maple River

ARENARIA SERPYLLIFOLIA L Thyme-leaved Sandwort E C

Ruderal, occasional Ingleside, Munro Lake, Cecil

ARENARIA LEPTOCLADOS Reichenb (*Arenaria leptoclados* Guss)

Railroad ballast near Van, Carp Lake and Cecil Sandy road into Big Stone Bay

ARENARIA STRICTA Michx Rock Sandwort E

In the heath association and on sand-dunes in Big Stone Bay

SPERGULA ARVENSIS L Spurry C

A weed in a field near Vincent Lake, 1916 and 1917

AGROSTEMMA GITHAGO L Corn Cockle E * C

In 1911 and 1913 abundant in an abandoned rye field near Vincent Lake Rare since

SILENE LATIFOLIA (Mill) Britten & Rendle Bladder Campion
E * C

Ruderal, occasional Grapevine Point

SILENE ANTIRRHINA L Sleepy Catchfly E C

Occasional in the aspens and open thickets, and as a weed in fields and along roads, becoming more frequent Cecil

SILENE NOCTIFLORA L Night-flowering Catchfly E C

In low places along roads

SILENE DICHOTOMA Ehrh C.

Farm-yard west of Lancaster Lake

LYCHNIS ALBA Mill White Campion E C

Ocasional in burnt-over areas and as a ruderal, but rapidly becoming more common. Cecil.

LYCHNIS CORONARIA (L) Desr Mullen Pink E C
A patch west of Burt Lake and others west of Pellston

GYPSOPHILA PANICULATA L C
Near an abandoned lumber camp in North Fishtail Bay region, 1915 Not present after 1920

DIANTHUS BARBATUS L Sweet William E * C
Escaped from cultivation near an Indian cottage west of Bryant's Last noted in 1915

SAPONARIA OFFICINALIS L Bouncing Bet E C
Locally abundant in certain farm-yards and occasional as a ruderal in the better soils Two or three patches with double flowers

135 PORTULACACEAE (Purslane Family)

CLAYTONIA CAROLINIANA Michx Spring Beauty E
Occasional in beech-maple woods around Petoskey, according to Mr Charles W Fallass, and should be present in the vicinity of the Biological Station, but has never yet been found there, possibly having completely withered up after developing in the early spring before the Biological Station opens

PORTULACA OLERACEA L Purslane E C
A weed in fields, uncommon

PORTULACA GRANDIFLORA Hook Garden Portulaca E C
Cultivated and escaping for a year or two near Pellston and Munro Lake

136 AIZOACEAE (Carpetweed Family)

MOLLUGO VERTICILLATA L Carpetweed E C
Railroad ballast near Indian River and west of Pellston

140 SALICACEAE (Willow Family)

POPULUS ALBA L Silver-leaf Poplar C
A few trees in different farm-yards, spreading by suckers West side of Burt Lake, Ingleside, Riggsville, etc

POPULUS BALSAMIFERA L Balsam Poplar E C
Locally abundant on ice-ridges, on dunes, in bogs, and along roads, spreading rather rapidly Making tall trees in Larix bogs, but otherwise mostly as a shrub or small tree Cecil

POPULUS GRANDIDENTATA Michx Large-toothed Aspen E C
One of the most abundant species in the region, dominating in the aspen association and occurring in several of the other associations in the region, especially on drier ground Seldom a large tree Sprouts the first year after a fire, sometimes ten and twelve feet high, with enormous leaves Cecil

POPULUS TREMULOIDES Michx Aspen E C
About the same status as *Populus grandidentata*, but prefers moister ground, consequently more often found in burnt-over bog land and on the ice-ridges around lakes More likely to grow into a tall tree, sometimes about sixty-five feet high, as in the bog land west of Lancaster Lake Cecil

POPULUS ITALICA Moench (*P nigra italica* Du Roi) Lombardy Poplar C
A few trees in a farm-yard on the west side of Burt Lake and in other similar places

POPULUS DELTOIDES Marsh Cottonwood E C
Uncommon, a few trees on an ice-ridge on the north side of Douglas Lake, Colonial Point on Burt Lake, and planted in Pellston

SALIX NIGRA Marsh Black Willow C
A few trees in a few farm-yards north of Douglas Lake

SALIX LUCIDA Muhl Shining Willow E C
One of the commonest shrubs in willow-thickets and invading many of the wet-ground associations Cecil

SALIX SERISSIMA (Bailey) Fernald Autumn Willow E C
Most frequently found at the limit of ice work around Douglas Lake, Marl Bay, Grapevine Point Also margins of bogs Cecil

SALIX INTERIOR Rowlee (*Salix longifolia* Muhl) Sandbar Willow E C

Along the shore and on low dunes around Douglas Lake On dunes the plants are often badly infested with larvae, as in 1917 and 1918 Cecil and Big Stone bays Common, but always as a shrub

SALIX PYRIFOLIA Anders (*S balsamifera* Barratt) Balsam Willow C

Reported by F M Loew in 1910

SALIX GLAUCOPHYLLA Bebb E C

On a low dune along the east side of Douglas Lake Cecil and big Stone bays

SALIX ADENOPHYLLA Hook (*S syrticola* Fernald) Furry Willow E C

Local on low dunes in the East Point region, the plants there are smaller than those along Lake Michigan in Cecil and Big Stone bays, where it is common

SALIX CANDIDA Fluegge E C

One of the dominant species in the Myrica association in bogs, but not common Cecil

SALIX SERICEA Marsh Silky Willow E * C

Edge of a cedar bog, west side of Douglas Lake

SALIX PETIOLARIS J E Smith E C

Shrub along the G R & I Railroad Riggsville Bog

SALIX BEBBIANA Sarg (*S rostrata* Richards) Beaked Willow E C

The most abundant willow in willow-thickets and in the aspens, although also in cedar bogs and beech-maple woods Cecil

SALIX DISCOLOR Muhl Pussy Willow E C

Very common in willow-thickets and wet ground generally Cecil

SALIX DISCOLOR × BEBBIANA C

A common hybrid in the aspens and in the beech-maple forest

SALIX HUMILIS Marsh E * C

In a swale south of Burt Lake Nichols in 1920

SALIX PEDICELLARIS Pursh Bog Willow E * C

A characteristic shrub in the low bog-thickets, readily invading the *Carex lasiocarpa* mat

145 AMARANTHACEAE (Amaranth Family)

AMARANTHUS RETROFLEXUS L Pigweed, Red Root E C
Ruderal and fireweed, not common

AMARANTHUS HYBRIDUS L E
At Bay View, according to C W Fallass

AMARANTHUS GRAECIZANS L Tumbleweed E C
Rather infrequent as a ruderal and a fireweed, but becoming more common Pellston Just west of Bryant's in 1919

AMARANTHUS BLITOIDES S Wats E * C
Reese's clearing, 1914 (Gleason and McFarland)

146 CHENOPODIACEAE (Goosefoot Family)

CHENOPODIUM ALBUM L Lamb's Quarters E C
A fireweed of limited distribution, also a ruderal and a field weed

CHENOPODIUM HYBRIDUM L Maple-leaved Goosefoot E C
A fireweed, not common Mill sites at Ingleside and W of Pellston

CHENOPODIUM BONUS-HENRICUS L Good King Henry E C
A weed near a saw-mill at Cecil Mill site in North Fishtail Bay region

CHENOPODIUM BOTRYS L E C
Railroad ballast, Mackinaw City and Indian River

BLITUM CAPITATUM L (*Chenopodium capitatum* (L) Asche) Strawberry Blite E C
A fireweed of limited distribution and a ruderal and field weed Mostly on the better classes of soils, but three plants found in the sand at the Biological Station in 1919

SALSOLA PESTIFER A Nelson (*Salsola kali tenuifolia* G F W. Mey) Russian Thistle E
Local in Pellston, mostly in vacant lots and along roads

147 POLYGONACEAE (Buckwheat Family)

RUMEX ACETOSELLA L Sheep Sorrel E C
A common fireweed, also abundant in the aspens and along roads Cecil

RUMEX MEXICANUS Meisn Willow-leaved Dock E C
In moist places Infrequent Cecil

RUMEX BRITANNICA L Great Water Dock C
On the mat at the mouth of Maple River

RUMEX OCCIDENTALIS S Wats C
Near the mouth of Maple River (Ehlers)

RUMEX CRISPUS L (The form called *Rumex elongatus* Guss in Gray's *Manual*) E C
Mostly as a ruderal, but also fairly frequent in the Iris association

RUMEX OBTUSIFOLIUS L Dock E C
Mostly as a ruderal, but in wet places in thickets along Burt Lake, west of Pellston and on hummocks at the mouth of Maple River

RHEUM RHAPONTICUM L Rhubarb E C
Cultivated and persisting on abandoned farms Infrequent

POLYGONUM AVICULARE L Knotweed E C
Ruderal

POLYGONUM ERECTUM L Erect Knotweed E C
Mill-yard at Pellston and at Bryant's, 1917 (H A Gleason)

POLYGONUM RAMOSISSIMUM Michx E
A ruderal collected in 1913, and as a weed in the parking in Mackinaw City in 1916, and Big Stone Bay in 1922

PERSICARIA AMPHIBIA (L) S F Gray (*Polygonum amphibium* L) E C
One of the dominant species in an aquatic association and in moist ground in thickets Forma *Hartwrightii* (Gray) is infrequent East Point

PERSICARIA LAPATHIFOLIA (L) S F Gray (*Polygonum lapathifolium* L) E C
Munro Lake and Maple River west of Pellston

PERSICARIA LAPATHIFOLIA var (*Polygonum tomentosum* Schrank, var *incanum* (Schmidt) Gurke) C
Collected near Bryant's hotel by F T McFarland in 1915

PERSICARIA PENNSYLVANICA (L) Small (*Polygonum pennsylvanicum* L) E C
A ruderal and field weed, not common

PERSICARIA PERSICARIA (L) Small (*Polygonum persicaria* L) Lady's Thumb E C

A ruderal, not common, but becoming more so Cecil

PERSICARIA HYDROPIPEROIDES (Michx) Small (*Polygonum hydropiperoides* Michx) Mild Water Pepper E C

In wet ground associations along the banks of Maple River, Bessey Creek, etc Cecil

PERSICARIA SETACEA (Baldw) Small (*Polygonum setaceum* Bald) E

Maple River west of Pellston (Ehlers)

PERSICARIA HYDROPIPER (L) Opiz (*Polygonum hydropiper* L) E C

Shore of Burt Lake at Colonial Point, west of Pellston and elsewhere

PERSICARIA PUNCTATA (Ell) Small (*Polygonum acre* H B K) Water Smartweed E C

In wet ground along roads through beech-maple woods, not common The var *leptostachya* (Meisn) occurs along Maple River, west of Pellston

FAGOPYRUM FAGOPYRUM (L) Karst (*Fagopyrum esculentum* Moench) Buckwheat E C

Cultivated frequently and quite commonly running wild as a ruderal

TINIARIA CONVOLVULUS (L) Webb & Moq (*Polygonum Convolvulus* L) Bindweed E C

Occasional in thickets, in the aspens, and as a ruderal Cecil

TINIARIA CILINODIS (Michx) Small (*Polygonum cilinode* Michx) E * C

A ruderal Occasional also in fields and in the beech-maple forest

POLYGONELLA ARTICULATA (L) Meisn E C

On a pine-covered dune southeastward from Big Stone Bay and on the jack pine plains south of Burt Lake

151 Primulacfae (Primrose Family)

Primula farinosa L (*Primula farinosa* var *americana* Torr) Bird's-eye Primrose E
A few plants at the edge of the Thuja association on a low ridge in a boggy area west of Cecil and abundant towards the end of Temperance Point

Lysimachia terrfstris (L) B S P Loosestrife E C
Fairly frequent in wet-ground associations such as the Iris and Calamagrostis Cecil

Steironema ciliatum (L) Raf C
Near the mouth of Maple River in a thicket, and at the lake edge of bogs at the head of Burt Lake, infrequent

Naumburgia thyrsiflora (L) Duby (*Lysimachia thyrsiflora* L) Tufted Loosestrife E C
Most frequently in Calamagrostis meadows, willow-thickets, pioneer stages of bogs, but locally very abundant on the beach in a cove west of Grapevine Point landward of the *Scirpus americanus* association Cecil

Trientalis americana Pursh Star Flower E C
Characteristic of the beech-maple ground layer, but occurring also in cedar bogs and in the Picea-Abies association Common

152 Plantaginaceae (Plantain Family)

Plantago major L Plantain E C
A ruderal, and farm-yard weed Infrequent

Plantago Rugelii Dcne E * C
Along Maple River and at Hook Point

Plantago lanceolata L Buckthorn Plantain E C
A ruderal, Pellston, Riggsville

157 Ericaceae (Heath Family)

Pterospora andromedea Nutt Pine Drops E
Occasional in a mixed coniferous forest between Cecil and Big Stone Bay

MONOTROPA UNIFLORA L Indian Pipe E C
Occasional in beech-maple forests and less frequently in other wooded areas Cecil

HYPOPITYS LANUGINOSA (Michx) Nutt (*Monotropa hypopitys* L) Pinesap E * C
Infrequent in cedar bogs, such as Reese's, and northwestward of Robert's Point, but several large clumps in a restricted area in the aspens near the Biological Station were found July 2, 1920

LEDUM GROENLANDICUM Oeder Labrador Tea E C
A low shrub, fairly common in tamarack and cedar bogs Cecil

KALMIA POLIFOLIA Wang Pale Laurel E C
Fairly frequent shrub in Chamaedaphne bogs, or along roads through cedar bogs

CHAMAEDAPHNE CALYCULATA (L) Moench Leatherleaf E C
A very common shrub in suitable places in the region, dominating a bog association, invading the *Carex lasiocarpa* association, remaining as a relict in cedar bogs and sometimes found in low places in the aspens Burnt-over bogs frequently grow up and remain in Chamaedaphne Cecil region, where it is very abundant in certain interdunal areas

ANDROMEDA POLIFOLIA L (*Andromeda glaucophylla* Link) Bog Rosemary E C
Frequent in Chamaedaphne bogs, along roads and in open places in cedar bogs Cecil

EPIGAEA REPENS L Trailing Arbutus E C
Occurs sparingly in the pine land aspens, cedar bogs and the Picea-Abies association

GAULTHERIA PROCUMBENS L Wintergreen E C
In cedar bogs and very common in the aspens, there a relict of pine dominance Cecil

UVA-URSI UVA-URSI (L) Britton (*Arctostaphylos Uva-Ursi* (L) Spreng) Bearberry E C
Representing the heath association in the aspens, particularly on the ice-ridge along Douglas Lake Also on dunes Cecil Bay and Big Stone Bay regions

GAYLUSSACIA BACCATA (Wang) K Koch Huckleberry E C
Rather abundant shrub in the aspens Kingsley's A few bushes of forma *glaucocarpa* (Robinson) Mackenzie occur in the Chamaedaphne association at Bryant's Bog

VACCINIUM CANADENSE Kalm Velvet-leaved Blueberry E C
In beech-maple woods, in the Chamaedaphne and aspen associations and on dunes along Douglas Lake, common A bush with black berries found by Ehlers in 1918 had all the other characteristics of this species Cecil The white-fruited shrub forma *chiococcum* Deane, has been found once or twice in the North Fishtail region

VACCINIUM ANGUSTIFOLIUM Ait (*V pennsylvanicum* Lam) Blueberry E C
A very abundant small shrub in the aspens and other burnt-over areas, the burning at more or less regular intervals being much more favorable to its presence in quantity than to the trees that would otherwise shade it too serverely Cecil

VACCINIUM NIGRUM (Wood) Britton (*V pennsylvanicum nigrum* Wood) Low Black Blueberry E C
With the preceding, frequent in the aspens Cecil

CHIOGENES HISPIDULA (L) T & G Creeping Snowberry E C
Fairly common in cedar bogs, especially on logs along roadways or other openings

OXYCOCCUS OXYCOCCOS (L) MacM (*Vaccinium Oxycoccos* L) Small Cranberry E C
In Chamaedaphne and cedar bogs Fruit very light-green and sometimes mottled (Mud Lake Bog) in August Common Cecil Var *intermedium* Gray occurs at Mud Lake

OXYCOCCUS MACROCARPUS (Ait) Pursh (*Vaccinium macrocarpon* Ait) Large or American Cranberry E C
In the Chamaedaphne association at Mud Lake and in bogs west of Cecil

160 Pyrolaceae (Wintergreen Family)

Pyrola americana Sweet E * C
Occasional in beech-maple forests
Pyrola chlorantha Sw E C
Occasional in beech-maple forests and in the aspens Cecil
Pyrola elliptica Nutt Shin-leaf E C
Fairly frequent in beech-maple forests and in the aspens
Pyrola uliginosa Torr (*Pryola asarifolia* var *incarnata* (Fisch) Fernald) E * C
Rather common in open places in cedar bogs
Pyrola asarifolia Michx E * C
Occasional in tamarack and cedar bogs
Pyrola secunda L E C
Common in tamarack and cedar bogs and occasional in beech-maple forests Cecil Var *obtusata* Turcz collected in Smith's Bog in 1911 by F C Gates (station now destroyed) and in Riggsville Bog in 1919 by Mrs C C Deam Emmet County (Fallass)
Moneses uniflora (L) A Gray E C
Locally abundant in cedar bogs Cecil
Chimaphila umbellata (L) Nutt Pipsissewa, Prince's Pine E C
Frequent in beech-maple forests and in pine land aspens Cecil

166 Polemoniaceae (Phlox Family)

Phlox paniculata L Garden Phlox C
Escaped from cultivation near a farm-house near Mud Lake, 1922

167 Convolvulaceae (Morning Glory Family)

Ipomoea purpurea (L) Lam Morning Glory C
A few plants in a yard near Mud Lake in 1919
Convolvulus Sepium L Hedge Bindweed E C
As a ruderal in isolated stations, rare Also in thickets

on the ice-ridge along Burt Lake, especially near Maple River and Carp Creek

CONVOLVULUS SPITHAMAEUS L E C

An abundant secondary species in the aspens, becoming more abundant

CONVOLVULUS ARVENSIS L Bindweed E * C

A single, although fairly large, patch in an orchard just west of Munro Lake and a second patch in a field east of Burt Lake, 1923 (F C Gates)

168 HYDROPHYLLACEAE (Waterleaf Family)

HYDROPHYLLUM VIRGINIANUM L Waterleaf E

A single small patch under a lumber platform in the mill-yard at Pellston Present only in 1916 and 1917

169 BORAGINACEAE (Borage Family)

CYNOGLOSSUM OFFICINALE L Hound's-Tongue E * C

Ruderal and field weed in the better soils Cecil

LAPPULA LAPPULA (L) Karst (*Lappula echinata* Gilibert) Stickseed E C

Occasional as a ruderal or a field weed in the better soils

LAPPULA TEXANA (Scheele) Britton (*L Redowskii* var *occidentalis* (Wats) Rydb) E

Occasional on railroad ballast and in the aspens, infrequent

LAPPULA VIRGINIANA (L) Greene Beggar's Lice E C

Occasional in wooded areas

LAPPULA DEFLEXA (Wahl) Garcke E * C

Occasional in the better soils

MYOSOTIS SCORPIOIDES L Forget-me-not E C

Abundant in ditches along the highway in Odin From there transplanted to the gorge in 1918, a small patch still persisting

LITHOSPERMUM ARVENSE L Corn Gromwell E C

Infrequent in fields and a single plant in the drift-line at the edge of Douglas Lake in Camp Davis

LITHOSPERMUM OFFICINALE L Gromwell E * C
Roadside on Colonial Point

LITHOSPERMUM CAROLINENSE (Walt) MacM (*Lithospermum Gmelini* (Michx) Hitchc) Hairy or Gmelin's Puccoon E
Characteristic, although not common on dunes in Big Stone Bay

SYMPHYTUM ASPERIMUM Donn (*S asperum* Lepechin) C
A few isolated clumps in ditches along roads in and about Riggsville, Mud Lake and north end of Burt Lake, escaped from cultivation

BORAGO OFFICINALIS L C
A few plants about an abandoned house north of Douglas Lake, June, 1917 (J H Ehlers)

ECHIUM VULGARE L Viper's Bugloss E * C
Rare, west of Lancaster Lake and north of Riggsville in a field

171 SOLANACEAE (Potato Family)

PHYSALIS SP ? Ground Cherry C
Along a road northeast of North Fishtail

PHYSALIS HETEROPHYLLA AMBIGUA (A Gray) Rydb Ground Cherry E * C
Occasionally as a fireweed or a field weed

LEUCOPHYSALIS GRANDIFLORA (Hook) Rydb (*Physalis grandiflora* Hook) White Ground Cherry E C
Three plants found in the North Fishtail aspens by F M Loew in 1911, specimens found in a cultivated field west of Lancaster Lake in 1920

SOLANUM NIGRUM L Garden Nightshade E C
Edges of cedar bogs and along roads through beech-maple forests and infrequently as a weed Cecil

SOLANUM TUBEROSUM L Potato E C
Frequently cultivated, and also seldom a waif from cultivation

LYCOPERSICUM LYCOPERSICUM (L) Karst (*L esculentum* Mill) Tomato E C
Frequently cultivated, seldom escaping.

DATURA STRAMONIUM L (*D tatula* L) Jimson weed C
As a ruderal at Crump's Corners and in a barn-yard near Nichols' Bog, rare

172 OLEACEAE (Olive Family)

SYRINGA VULGARIS L Lilac E C
Cultivated in yards and persisting after abandonment West of Pellston

FRAXINUS AMERICANA L White Ash E C
One of the less abundant dominant species in the beech-maple forest and occasional in lowland woods

FRAXINUS PENNSYLVANICA Marsh Green or Red Ash E * C
A few trees near the head of Burt Lake

FRAXINUS NIGRA Marsh Black Ash E C
The most abundant tree in the lowland woods and plentiful in tamarack and cedar bogs, readily invading almost any low areas Exceedingly abundant (with much enlarged bases) in the deltas of Maple and Crooked rivers

175 GENTIANACEAE (Gentian Family)

GENTIANA PROCERA Holm Smaller Fringed Gentian E
A single plant found along a sandy ridge three or four miles east of Cecil

GENTIANA ANDREWSII Griseb (Dasystephana in B & B , ed 2)
Closed Gentian C
In developing cedar bogs, rare East Point

GENTIANA LINEARIS Froel (Dasystephana in B & B , ed 2) E
Rare, Sturgeon Bay

GENTIANA GRAYI Kusnezow (Dasystephana in B & B , ed 2)
(*Gentiana linearis* var *latifolia* Gray) E C
Occasional in the fourth bog at East Point and at Cecil

HALENIA DEFLEXA (J E Smith) Griseb Spurred Gentian E C
Now rare along a road in Reese's Bog, but frequent in the Big Stone Bay region

MENYANTHES TRIFOLIATA L Buckbean E C
Occasional in bogs, sometimes as an association, at other

times as a few plants merely Bryant's and Mud Lake bogs Forming a large association on the mat at the mouth of Maple River, which is being replaced by Typha rather rapidly

176 APOCYNACEAE (Dogbane Family)

APOCYNUM ANDROSAEMIFOLIUM L Spreading Dogbane E C
In the aspens and in beech-maple woods, becoming more frequent Cecil

APOCYNUM MEDIUM Greene C
In the jack pine plains south of Burt Lake

APOCYNUM CANNABINUM L C
Occasional in sandy areas

APOCYNUM SIBIRICUM Jacq (*A cannabinum* var *hypericifolium* (Ait) Gray) E C
On dunes and fringing ice-ridges and occasional in the aspens

177 ASCLEPIADACEAE (Milkweed Family)

ASCLEPIAS TUBEROSA L Butterfly-weed C
Infrequent in the jack pine plains south of Burt Lake

ASCLEPIAS INCARNATA L Swamp Milkweed E C
Occasional in willow-thickets, but fairly abundant in the Iris and other marsh associations Cecil

ASCLEPIAS EXALTATA (L) Muhl (*A phytolaccoides* Pursh) C
Infrequent in the aspens near the Biological Station, spreading

ASCLEPIAS SYRIACA L Common Milkweed E C
Occasional in the aspens and abundant as a weed in fields and in abandoned yards, spreading rapidly Cecil

178 SCROPHULARIACEAE (Figwort Family)

VERBASCUM THAPSUS L Mullen E C
A ruderal and fairly common in the brambles, aspens and abandoned fields Very scarce in some years Cecil

VERBASCUM BLATTARIA L Moth Mullen E
Rare, roadside west of Pellston (Ehlers)

LINARIA LINARIA (L) Karst (*Linaria vulgaris* Hill) Butter-and-eggs E C

A ruderal in Pellston and on the ice-ridge along the east side of Munro Lake Not common

SCROPHULARIA LEPORELLA Bicknell Figwort E C

A ruderal both in the open and in woods, infrequent but spreading rapidly

CHELONE GLABRA L Turtle-head E C

In boggy ground at the head of Burt Lake, near the mouth of Maple River and at Cecil, rare

MIMULUS RINGENS L Monkey-flower E * C

Not common, in willow-thickets, ditches, and in the Iris association along Maple River

MIMULUS GEYERI Torr (*M glabratus* var. *Jamesii* (T & G) Gray) E * C

In streams through cedar bogs, locally abundant in Carp Creek in the gorge

VERONICA ANAGALLIS-AQUATICA L Water Speedwell E C

An aquatic in Bessey Creek and Maple River west of Pellston

VERONICA AMERICANA Schwein American Brooklime E * C

Occasional along streams through cedar bogs

VERONICA SCUTELLATA L Marsh Speedwell C

In marshes near Bessey Creek

VERONICA SERPYLLIFOLIA L Thyme-leaved Speedwell E * C

Ruderal in aspens and in beech-maple forests, infrequent

VERONICA PEREGRINA L Purslane Speedwell E

Weed in garden in Pellston

VERONICA ARVENSIS L Corn Speedwell E C

Occasional in the aspens north of Douglas Lake and as a garden or field weed

AGALINIS PAUPERCULA (A Gray) Britton (*Gerardia paupercula* (Gray) Britton) E

In interdunal boggy areas along Lake Michigan west of Cecil

CASTILLEJA COCCINEA (L) Spreng Painted-cup E C

In a low spot in the aspens southward from Vestal's Bog,

1923 Locally abundant in low ground in the Cecil-Big Stone Bay region

PEDICULARIS CANADENSIS L Lousewort E C

Frequent in the aspens

MELAMPYRUM LINEARE Lam Cow-Wheat E C

An abundant secondary species in the aspens Cecil

179 BIGNONIACEAE (Bignonia Family)

CATALPA SPECIOSA Warder Catalpa E

Sparingly cultivated tree in Pellston Tips of shoots frequently winter-killed

182 OROBANCHACEAE (Broom-rape Family)

CONOPHOLIS AMERICANA (L f) Wallr Cancer-root C

At least one patch in the beech-maple forest on Colonial Point, 1922 (G E Nichols)

LEPTAMNIUM VIRGINIANUM (L) Raf (*Epifagus virginiana* (L) Bart) Beechdrops E * C

In beech-maple woods north of Douglas Lake in 1915 (H A Gleason and others) Locality since cut over

185 LENTIBULARIACEAE (Bladderwort Family)

PINGUICULA VULGARIS L Butterwort E

In a low area on Temperance Point

UTRICULARIA INTERMEDIA Hayne Bladderwort E * C

Along a little stream in Mud Lake Bog and at Sedge Point

UTRICULARIA MACRORHIZA LeConte (*U vulgaris* var *americana* Gray) E C

Occasional in aquatic associations

UTRICULARIA RESUPINATA B D Greene (*Lecticula Barnhart* in B & B , ed 2) E * C

Locally fairly abundant at Deer Bay, Maple Bay and at the south edge of Marl Bay Seldom seen as it flowers only in very dry summers when the water of Douglas Lake is low and warm, as in 1916 and 1921

UTRICULARIA CORNUTA Michx (Stomoisia Raf in B & B, ed 2) Bladderwort E C
Locally common in *Scirpus americanus* associations on sandy shores of Douglas Lake Cecil

189 PHRYMACEAE (Lopseed Family)

PHRYMA LEPTOSTACHYA L Lopseed C
One patch along a road near the tip of Colonial Point in the beech-maple forest, 1922

190 VERBENACEAE (Vervain Family)

VERBENA HASTATA L Blue Vervain E C
A ruderal, also in grassy thickets, infrequent West of Pellston

VERBENA STRICTA Vent Hoary Vervain E
One large clump along a road west of Pellston

VERBENA BRACTEOSA Michx Large bracted Vervain C
A ruderal in the better soils

VERBENA CANADENSIS (L) Britton C
Three clumps along a road in Riggsville, probably an escape

191 LAMIACEAE (Labiatae) (Mint Family)

TEUCRIUM CANADENSE L C
Shore of Burt Lake, rare

TEUCRIUM OCCIDENTALE A Gray Hairy Germander C
In a marsh south of Burt Lake Var *boreale* (Bicknell) Fernald, occurs in the North Fishtail region and in a grassy thicket at the mouth of Carp Creek

SCUTELLARIA LATERIFLORA L Mad-dog or Blue Skullcap E C
In bogs, infrequent West of Pellston, Cecil, Big Stone Bay

SCUTELLARIA GALERICULATA L Marsh Skullcap E C
Rather common in the Iris and other marsh associations Cecil

MARRUBIUM VULGARE L Hoarhound E * C
In wet places in two roads in Riggsville in 1911 (F C Gates) Stations since destroyed

NEPETA CATARIA L Catmint E C
A ruderal, occasional in the areas of better soils Cecil

GLECOMA HEDERACEA L (*Nepeta hederacea* (L) Trevisan) Ground Ivy E C
Escaped in a few places near Ingleside and west of Pellston

PRUNELLA VULGARIS L Self-heal E C
Abundant along roads and streams in the beech-maple forest and in cedar bogs, in the latter habitat usually more or less dwarfed

GALEOPSIS TETRAHIT L Hemp Nettle E C
Disturbed places in the beech-maple forest near Burt Lake and west of Pellston as well as occasionally as a ruderal

LEONURUS CARDIACA L Motherwort E C
An infrequent ruderal west of Pellston in good soil, also near the head of Burt Lake

LAMIUM MACULATUM L Spotted Dead Nettle C
Along a road north of Douglas Lake

LAMIUM ALBUM L White Dead Nettle C
Roadside in Riggsville

STACHYS PALUSTRIS L E C
Occasional, head of Burt Lake, in the aspens west of Bryant's, west of Pellston, and at Cecil

STACHYS ASPERA Michx (*Stachys tenuifolia* var *aspera* (Michx) Fernald) Ruff Hedge Nettle C
Occasional along the west shore of Burt Lake

MONARDA FISTULOSA L Wild Bergamot E C
In the beech-maple forest on Colonial Point, Burt Lake, and westward, Big Stone Bay

MONARDA MOLLIS L E C
Colonial Point, Mackinaw City, and jack pine plains south of Burt Lake

HEDEOMA PULEGIOIDES (L) Pers American Pennyroyal E * C
A single locality — in cow dung in a field near Nichols' Bog, 1923

CLINOPODIUM VULGARE L (*Satureja vulgaris* (L) Fritsch E C

In thickets, aspens and roadsides, frequent Cecil

CLINOPODIUM ACINOS (L) Kuntze (*Satureja acinos* (L) Scheele) C

Introduced about the Biological Station in 1912, from where it spread into the aspens for a few years, but failed to maintain itself Reese's Clearing, 1923

CLINOPODIUM GLABRUM (Nutt) Kuntze (*Satureja glabra* (Nutt) Fernald) E

Very abundant on a flat on Temperance Point

LYCOPUS UNIFLORUS Michx Bugleweed E C

Occasional in boggy areas, Reese's Bog, East Point, Burt Lake ice-ridges, west of Pellston and Cecil

LYCOPUS AMERICANUS Muhl Water Hoarhound E C

In several aquatic and semi-aquatic marsh associations, common, Cecil

MENTHA SPICATA L Spearmint E * C

Roadsides north of Douglas Lake, Munro Lake

MENTHA PIPERITA L Peppermint E * C

Roadside ditch east of Douglas Lake, mouth of Bessey Creek

MENTHA CANADENSIS L (*M arvensis* var *canadensis* (L) Briquet) Mint E C

In a number of wet-ground associations of herbaceous plants and persisting into thickets, sandy shores

192 ROSACEAE (Rose Family)

OPULASTER OPULIFOLIUS (L) Kuntze (*Physocarpus opulifolius* (L) Maxim) Ninebark E

A shrub along West Maple River Cecil

SPIRAEA ALBA Du Roi (*S salicifolia* L) E C

A shrub in willow-thickets, invading the Chamaedaphne association at Smith's Bog West of Pellston and in marshes south of Burt Lake

POTENTILLA CANADENSIS L Five-Finger E * C

In a tamarack bog northwest of Ingleside and in the aspens near the Hogback Bog.

POTENTILLA MONSPELIENSIS L Cinquefoil E C
On fringing dunes, in willow-thickets and as a ruderal, fairly frequent Cecil

POTENTILLA ARGENTEA L Silvery Cinquefoil E C
Locally abundant in the mill-yard at Pellston and occasional as a ruderal elsewhere South of Burt Lake on jack pine plains

POTENTILLA RECTA L E C
In a mill-yard in Pellston and as a ruderal near Levering and Mud Lake

ARGENTINA ANSERINA (L) Rydb (*Potentilla anserina* L) Silverweed E C
Dominating the *Potentilla anserina* association and occurring in a few other beach associations around Douglas and Burt lakes Cecil

COMARUM PALUSTRE L (*Potentilla palustris* (L) Scop) Marsh Five-Finger E C
In the Cladium and *Carex lasiocarpa* as well as in other marsh and bog associations, mostly aquatic Cecil

FRAGARIA GRAYANA Vilmorin Strawberry E
Railroad ballast north of Pellston

FRAGARIA VIRGINIANA Duchesne Strawberry E C
Common on low ground

FRAGARIA AMERICANA (Porter) Britton (*F vesca* var *americana* Porter) E C
Occasional in cedar bogs

SIBBALDIOPSIS TRIDENTATA (Soland) Rydb (*Potentilla tridentata* Ait) Three-toothed Cinquefoil E
A single but rather large patch in the right-of-way of the G R & I Railroad about one mile north of Pellston

DASIPHORA FRUTICOSA (L) Rydb (*Potentilla fruticosa* L) Shrubby Cinquefoil E C
Local in boggy areas along West Maple River, Munro Lake, Cecil

DRYMOCALLIS AGRIMONIOIDES (Pursh) Rydb (*Potentilla arguta* Pursh) C
Local along a road north of Lancaster Lake and also near Mud Lake

AGRIMONIA GRYPOSEPALA Wallr E C
Roadways through beech-maple forests and less frequently through cedar bogs

GEUM CANADENSE Jacq White Avens E * C
Occasional in willow-thickets and beech-maple slashings

GEUM MACROPHYLLUM Willd E * C
A few plants in a tamarack bog northwest of Ingleside

GEUM STRICTUM Ait Yellow Avens E C
Pasture lands and along roads through beech-maple woods and cedar bogs

GEUM VERNUM (Raf) T & G E
Along West Maple River

GEUM RIVALE L Purple or Water Avens E C
Occasional in wet ground of various sorts Gorge

RUBUS ODORATUS L E
A low shrub in aspens west of Cecil

RUBUS PARVIFLORUS Nutt
A low shrub in aspens along the road between Cecil and Big Stone Bay

RUBUS STRIGOSUS Michx Wild Red Raspberry E C
(*Rubus idaeus* var *aculeatissimus* (C A Mey) Regel & Tiling)
Dominant in the bramble association especially when occurring on burnt-over beech-maple land, and present in the aspens as well as in other associations, common

RUBUS IDAEUS L (of Gray's *Manual*, 7th Edit) C
A few bushes found along Maple River

RUBUS NEGLECTUS Peck Purple Wild Raspberry C
A few bushes found in the openings in the second-growth woods on Grapevine Point

RUBUS OCCIDENTALIS L Black Raspberry E * C
Cultivated along Lancaster Lake, found once as an escape

RUBUS TRIFLORUS Richards Dwarf Red Blackberry E C
Abundant in bogs, also in low places in beech-maple woods and in the aspens Cecil

RUBUS CANADENSIS L Blackberry E * C
A shrub in the North Fishtail aspens and Riggsville Bog

RUBUS ALLEGHANIENSIS Porter Blackberry E C
Dominant in the bramble association especially on the sandier ground and more or less common in the aspens Very common Cecil

RUBUS PROCUMBENS Muhl (*Rubus villosus* Ait) Dewberry C
Occasional in the aspens near shores

ROSA BLANDA Ait Wild Rose E C
Frequent in the aspens along the shore of Douglas Lake and elsewhere Cecil

ROSA ACICULARIS Lindl Prickly Rose E C
On ridges along Burt Lake, Cecil

ROSA CAROLINA L Swamp Wild Rose E C
One of the dominating shrubs in a wet-ground association, usually bordering streams or lakes Maple River, Bessey Creek, etc Cecil

193 MALACEAE (Apple Family)

SORBUS AMERICANA Marsh (*Pyrus americana* (Marsh) DC) Mountain Ash E C
Infrequent in the Picea-Abies association and present also in cedar bogs West of Pellston and Cecil

MALUS MALUS (L) Britton (*Pyrus Malus* L) Apple E C
Escaped about abandoned lumber camps, farm-houses, etc

ARONIA ARBUTIFOLIA (L) Ell (*Pyrus arbutifolia* (L) L f) Chokeberry E * C
A dominant shrub in certain bog thickets, Bryant's

ARONIA ATROPURPUREA Britton (*Pyrus arbutifolia* var *atropurpurea* (Britton) Robinson) Purple-fruited Chokeberry E C
With *Aronia arbutifolia*, but more abundant A dominant shrub in certain bog thickets, especially after the removal of the original forest, northwest of Lancaster Lake Invades the Chamaedaphne association readily Abundant

ARONIA MELANOCARPA (Michx) Britton (*Pyrus melanocarpa* (Michx) Willd) Black Chokeberry E C
Frequent in cedar bogs

AMELANCHIER CANADENSIS (L) Medic June-berry, Service-berry (Probably including *A laevis* Wiegand) E C

As an under shrub in tree associations, particularly the aspens, or a tree in exposed situations on dunes and the ice-ridge around the lakes Common Cecil

AMELANCHIER SPICATA (Lam) C Koch Low Shad-bush C

A low shrub, 1 to 1 5 feet high, growing in patches and often fruiting exceedingly abundantly

AMELANCHIER SANGUINEA (Pursh) DC E C

With *A canadensis*, a shrub or a small tree Cecil

CRATAEGUS MACROSPERMA Ashe C

A few small trees in the beech-maple forest on Colonial Point

CRATAEGUS (nearest to *C roanensis* Ashe) C

Occasional small bushes in the aspens back of Camp Davis Becoming more abundant and spreading

194 PRUNACEAE (Peach Family)

PRUNUS NIGRA Ait Canada Plum E * C

A few trees in the beech-maple forest on Colonial Point, the north end of Burt Lake, and in the aspens in the North Fishtail region

PRUNUS PUMILA L Sand Cherry E C

A few shrubs on sand-dunes and ice-ridges along Douglas Lake, becoming more common Plentiful at Cecil and Big Stone bays Jack pine plains south of Burt Lake

PRUNUS PENNSYLVANICA L f Wild Red, Pin, or Fire Cherry E C

A dominant species in the aspens, relatively more abundant than *Populus spp* where the aspen association has followed on burnt-over beech-maple areas

PADUS NANA (Du Roi) Roemer (*Prunus virginiana* L) Choke-cherry E C

Occasional in the aspens, willow-thickets and brambles Cecil

PADUS VIRGINIANA (L) Mill (*Prunus serotina* Ehrh) Wild Black Cherry C

Occasional in the aspens and beech-maple forests

199 FABACEAE (Pea Family)

MEDICAGO SATIVA L Alfalfa E C
Sparingly cultivated and escaping as a ruderal

MEDICAGO LUPULINA L E * C
In a pasture north of Ingleside

MELILOTUS ALBA Desv White Sweet Clover E C
Local in cultivated ground

MELILOTUS OFFICINALIS (L) Lam Yellow Sweet Clover E
Rare, around barns in Pellston and at Mackinaw City

TRIFOLIUM AGRARIUM L Yellow or Hop Clover C
A few patches along roads or in fields, rare

TRIFOLIUM PROCUMBENS L Low Hop Clover E
Woodland path near Carp Lake

TRIFOLIUM PRATENSE L Red Clover E C
Widely cultivated and freely escaping to various habitats, especially along roads in the aspens Cecil

TRIFOLIUM HYBRIDUM L Alsike Clover E C
Same status as the preceding Cecil

TRIFOLIUM REPENS L White Clover E C
Same status as the two preceding, but more common than either, especially in low ground Cecil

ROBINIA PSEUDO-ACACIA L Black Locust E
Occasionally planted in towns

ROBINIA VISCOSA Vent Clammy Locust C
Planted along the Topinabee Road

MEIBOMIA CANADENSIS (L) Kuntze (*Desmodium canadense* (L) DC) Tick-trefoil C
A few plants in the second-growth beech-maple woods on Colonial Point and in thickets along Maple River

VICIA VILLOSA Roth C
Cultivated and rather freely escaping in the better soils

LATHYRUS MARITIMUS (L) Bigel Beach Pea E
A characteristic species of Ammophila dunes in Cecil and Big Stone bays Seeds have repeatedly been brought from there to the Ammophila dune at Douglas Lake, but no plants from them have been seen as yet

LATHYRUS VENOSUS Muhl C
Near Bryant's in 1917 and on Colonial Point in 1923

LATHYRUS PALUSTRIS L Vetchling E C
Occasional in open dune thickets along Douglas Lake Cecil

LATHYRUS MYRTIFOLIUS Muhl (*L palustris* var *myrtifolius* (Muhl) Gray) E C
In open places and in open beach thickets along Douglas and Burt lakes

GLYCINE APIOS L (*Apios tuberosa* Moench) Ground-nut E C
Occasional in beach pools, on dunes, and in open dune thickets along Douglas and Burt lakes Becoming more frequent

FALCATA PITCHERI (T & G) Kuntze (*Amphicarpa Pitcheri* T & G) Hog peanut C
Infrequent in open areas along the east side of Burt Lake

200 SAXIFRAGACEAE (Saxifrage Family)

PARNASSIA CAROLINIANA Michx E
Infrequent in boggy areas west of Cecil

PARNASSIA PARVIFLORA DC E
Low ground on Temperance Point Little Traverse Bay

TIARELLA CORDIFOLIA L False Mitrewort E
Wet spots in beech-maple forests west and north of Pellston, infrequent

MITELLA NUDA L Bishop's Cap E C
Common in cedar bogs, also occurring in beech-maple forests

CHRYSOPLENIUM AMERICANUM Schwein C
Sandy margin of a bog stream entering Burt Lake from Reese's Bog, rare

202 GROSSULARIACEAE (Gooseberry Family)

RIBES LACUSTRE (Pers) Poir Swamp Black Currant E * C
Recorded by F M Lowe in 1910 from the vicinity of Ingleside

RIBES HUDSONIANUM Richards Northern Black Currant C
A few times found in cedar bogs and in the gorge, rare Possibly a new southern limit for this species

RIBES NIGRUM L Black Currant E
In cultivation

RIBES TRISTE Pall American Red Currant E C
Common in bogs and occasional elsewhere, especially var *albinervium* (Michx) Fernald

RIBES GLANDULOSUM Grauer (*R prostratum* L'Hér) Skunk Currant E C
Occasional in cedar bogs

RIBES AMERICANUM Mill (*R floridum* L'Hér) Wild Black Currant E C
Occasional in thickets and woods Cecil

RIBES ODORATUM Wendl Golden Currant E
Cultivated in Pellston

GROSSULARIA CYNOSBATI (L) Mill (*Ribes Cynosbati* L) Prickly Gooseberry E C
A dominant species in the bramble association and present in willow-thickets, cedar bogs and less frequently in the aspens

GROSSULARIA OXYACANTHOIDES (L) Mill (*Ribes oxyacanthoides* L) Smooth Gooseberry E
Occasional in wet woods west of Pellston Cecil

GROSSULARIA HIRTELLA (Michx) Spach (*Ribes oxyacanthoides* var *calcicola* Fernald) C
Reese's Bog

203 CRASSULACEAE (Orpine Family)

SEDUM TRIPHYLLUM (Haw) S F Gray (*Sedum purpureum* Tausch) E
Formerly cultivated at a farm-house north of Pellston, remaining after abandonment

SEDUM ACRE L Stonecrop E C
Occasional near the shore at a few points, especially along the north side of Douglas Lake, Bryant's, and abundant along a road in the outskirts of Levering Cecil

204 Droseraceae (Sundew Family)

Drosera rotundifolia L Sundew E C
Fairly common on logs and in moss in open places and along roads in cedar and Chamaedaphne bogs Cecil

Drosera intermedia Hayne (*D longifolia* L) E * C
In Sphagnum in the Mud Lake bog

Drosera longifolia L (*Drosera anglica* Huds) E
Local in the marly margin of a developing beach-pool bog West of Cecil

Drosera linearis Goldie E
In a beach pool west of Cecil

211 Hamamelidaceae (Witch Hazel Family)

Hamamelis virginiana L Witch Hazel E * C
In the gorge and in the aspens east of the gorge, infrequent

215 Lythraceae (Loosestrife Family)

Decodon verticillatus (L) Ell Swamp Loosestrife or Willow-herb E * C
At the outer edge of vegetation around parts of Vincent Lake, the north and south ends of Munro Lake, and in the northeast part of Lancaster Lake Has been transferred to Douglas Lake, but without success Aerenchymous tissue well developed

223 Oenotheraceae (Evening Primrose Family)

Isnardia palustris L (*Ludvigia palustris* (L) Ell) Water Purslane E C
A few patches along Bessey Creek, especially towards Lancaster Lake, on a grassy road west of Munro Lake, and along Maple River west of Pellston

Chamaenerion angustifolium (L) Scop (*Epilobium angustifolium* L) Fireweed E C
The most abundant fireweed in the region, persisting in

many associations even to the dense beech-maple forest where however it seldom flowers Cecil

EPILOBIUM LINEARE Muhl (*E densum* Raf) E * C

Occasional Mud Lake bog and Pine Point

EPILOBIUM STRICTUM Muhl (*E molle* Torr) E * C

In the Mud Lake bog in a small stream

EPILOBIUM ADENOCAULON Haussk E C

As a fireweed in wet ground and in several wet ground associations Cecil

OENOTHERA BIENNIS L Evening Primrose E C

A ruderal and occasional in the aspens Cecil

OENOTHERA MURICATA L Northern Evening Primrose E C

Occasional as a ruderal and locally abundant on the ice-ridge of Douglas Lake near Camp Davis Cecil

OENOTHERA OAKESIANA Robbins E

Three plants in ballast at Cecil, 1921

KNEIFFIA PUMILA (L) Spach (*Oenothera pumila* L) C

A single station in a small roadside bog north of North Fishtail, 1920 (Mrs L S Ehlers)

CIRCAEA LUTETIANA L Enchanter's Nightshade E C

Fairly common in the beech-maple forest

CIRCAEA INTERMEDIA Ehrh C

Beech-maple forests, uncommon

CIRCAEA ALPINA L E C

Very common in the Picea-Abies association in the gorge and in cedar bogs

224 HALORAGIDACEAE (Water Milfoil Family)

HIPPURIS VULGARIS L Mare's-tail E C

In small quantities near an abandoned saw-mill at the head of Burt Lake, on the north shore of Lancaster Lake, Maple River west of Pellston and Crooked River Aquatic

PROSERPINACA PALUSTRIS L (*P palustris* var *amblyogona* Fernald) Mermaid-weed E C

Occasional in beach pools Cecil

MYRIOPHYLLUM SPICATUM L Water-Milfoil E C

In nearly all the strictly aquatic associations of lakes and streams of the region, especially abundant in the Potamogeton association

MYRIOPHYLLUM HETEROPHYLLUM Michx E C
A few plants in Crooked River near Alanson and in the mouth of Maple River

232 CUCURBITACEAE (Gourd Family)

CITRULLUS CITRULLUS (L) Karst (*Citrullus vulgaris* Shrad) Watermelon C
A few vines on the back strand at the tip of Colonial Point, 1921

MICRAMPELIS LOBATA (Michx) Greene (*Echinocystis lobata* (Michx) T & G) Wild Balsam-Apple E C
Often cultivated as an ornamental in Pellston and persisting in some abandoned farm-yards near Burt Lake

236 RHAMNACEAE (Buckthorn Family)

RHAMNUS ALNIFOLIA L'Hér Alder-leaved Buckthorn E C
In bog thickets, cedar bogs and in lowland woods Cecil

CEANOTHUS AMERICANUS L New Jersey Tea C
Jack pine plains south of Burt Lake

CEANOTHUS OVATUS Desf C
Jack pine plains south of Burt Lake

237 VITACEAE (Grape Family)

VITIS VULPINA L Grape E C
In dune thickets along lakes and streams Grapevine Point

PARTHENOCISSUS QUINQUEFOLIA (L) Planch (*Psedera quinquefolia* (L) Greene) Virginia Creeper E * C
Thickets and second-growth upland woods, not very common

238 CELASTRACEAE (Staff-Tree Family)

EUONYMUS SP C
Ground shrub in beech-maple forests, never found in flower

CELASTRUS SCANDENS L Bittersweet C
A liana in beech-maple forests, especially those along Burt Lake Abundant on Grapevine Point

240 AQUIFOLIACEAE (Holly Family)

ILEX VERTICILLATA (L) A Gray Virginia Winterberry, Holly E C
In bog-thickets, especially abundant back of Sedge Point, and in Vestal's Bog West of Pellston and Cecil

NEMOPANTHUS MUCRONATA (L) Trelease Mountain Holly E C
Frequent in bogs, but occasionally in aspens and beech-maple forests Succeeding the Chamaedaphne association over considerable of Bryant's Bog Cecil

250 THYMELAEACEAE (Mezereum Family)

DIRCA PALUSTRIS L Moosewood E * C
Formerly a single bush in a beech-maple forest in North Fishtail Bay previous to lumbering in 1916–1917 A few bushes in the beech-maple forest on Colonial Point

252 ELAEAGNACEAE (Oleaster Family)

LEPARGYRAEA CANADENSIS (L) Greene (*Shepherdia canadensis* (L) Nutt) Buffalo-berry E C
Three stations in the aspens in the general vicinity of Douglas Lake, northwest of Lancaster Lake, but rather common between Cecil and Big Stone Bay

254 SANTALACEAE (Sandalwood Family)

COMANDRA UMBELLATA (L) Nutt Bastard Toad-flax E C
A very abundant secondary species in the aspens Cecil

COMANDRA LIVIDA Richards E C
Twice found at the head of Burt Lake in Reese's Bog Locally common on pine and heath dunes in Big Stone Bay

.258 Loranthaceae (Mistletoe Family)

Razoumofskya pusilla (Peck) Kuntze (*Arceuthobium pusillum* Peck) Dwarf Mistletoe E C
Parasitic on *Picea mariana* (less frequently on Larix) in Bryant's, Mud Lake, Riggsville, and Vestal's bogs In Big Stone Bay region also on *Picea canadensis*

262 Aceraceae (Maple Family)

Acer saccharinum L Soft Maple E * C
A few trees, mostly large, along the shore of Douglas Lake

Acer rubrum L Red Maple E C
One of the commonest species in the lowland woods and in other lowland and boggy situations, but also in the aspens and beech-maple woods Cecil

Acer saccharum Marsh Sugar or Hard Maple E C
Very common, a dominant tree in the beech-maple forests Readily invades many associations One of the most abundant trees of the region Cecil

Acer pennsylvanicum L Striped Maple, Moosewood E C
Occurring on the borders of bogs, but characteristically an undershrub in the beech-maple forest Cecil

Acer spicatum Lam Mountain Maple E C
Most abundant in the Picea-Abies association, but also very common in cedar and tamarack bogs and to a limited extent in the beech-maple forest Cecil

Acer negundo L Box Elder E C
A few trees planted in Pellston and in other towns

268 Anacardiaceae (Sumac Family)

Rhus hirta (L) Sudw (*Rhus typhina* L) Staghorn Sumac E C
In the aspens, rare West of Lancaster Lake, Cecil

Rhus glabra L Smooth Sumac E C
A shrub present in the aspens, openings in different types of forests, and often abundant along roads and abandoned

fields in the better soils Most of the plants belong to *Rhus glabra borealis* Britton

TOXICODENDRON RADICANS (L) Kuntze (*Rhus radicans* L, *R toxicodendron* L) Poison Ivy E C
In dune thickets, especially on the ice-ridge margining Douglas and Burt lakes Occasionally in the beech-maple forest Cecil

269 JUGLANDACEAE (Walnut Family)

JUGLANS NIGRA L Black Walnut E * C
Planted along roads near Burt Lake and east from Munro Lake

JUGLANS CINEREA L Butternut E * C
Planted along a roadway east from Munro Lake

270 BETULACEAE (Birch Family)

OSTRYA VIRGINIANA (Mill) Willd (*O virginiana* (Mill) K Koch) Hop-Hornbeam E C
A small tree, occasional in beech-maple forests

CORYLUS ROSTRATA Ait Beaked Hazelnut E C
A shrub, very common in the aspens and in bog thickets

BETULA PAPYRIFERA Marsh (*B alba* var *papyrifera* (Marsh) Spach) Paper, Canoe or White Birch E C
Abundant, a dominant species in the aspens, but occurring in other associations Partial to back-shore conditions Cecil

BETULA SP (possibly *B lenta* L) Cherry, or Sweet Birch
A few trees in the gorge E * C

BETULA LUTEA Michx f Yellow Birch E C
Most abundant in the beech-maple forest, where it frequently grows to a very large tree, but also occurring in other tree associations Cecil

BETULA GLANDULOSA Michx Glandular Birch E C
Formerly in Smith's Bog, until burnt out in 1914 Occasional along West Maple River Locally abundant in the southeastern part of Mud Lake bog and in bogs northwest of Ingleside

ALNUS INCANA (L) Willd Alder E C
A dominant shrub in the high bog-shrub association Cecil

271 FAGACEAE (Beech Family)

FAGUS GRANDIFOLIA Ehrh Beech E C
Common, a dominant tree in the beech-maple forest and occurring in other associations as an invader Cecil
QUERCUS RUBRA L Red Oak E * C
A few trees in the beech-maple forest on Colonial Point
QUERCUS BOREALIS Michx f (included in *Q rubra* L) E C
A few old trees occur in beech-maple woods, seedlings, stump sprouts and young trees occur in other associations, especially in the aspens Cecil
QUERCUS VELUTINA Lam Black Oak E * C
Infrequent in the jack pine plains south of Burt Lake
QUERCUS ALBA L White Oak E * C
A few trees along the street in Topinabee, at least one large tree on a hill north of Fontinalis Run, and occasional at the southern end of Burt Lake

272 MYRICACEAE (Bayberry Family)

MYRICA GALE L Sweet Gale E C
A low shrub, dominating a bog association and remaining as a relict in willow-thickets ,and cedar bogs With root tubercles Cecil
COMPTONIA PEREGRINA (L) Coulter (*Myrica asplenifolia* L) Sweet Fern C
Locally in pine land aspens, especially west of the gorge, spreading Also on the jack pine plains south of Burt lake

275 ARALIACEAE (Ginseng Family)

ARALIA RACEMOSA L American Spikenard E C
In beech-maple woods and in cedar bogs Cecil
ARALIA NUDICAULIS L Wild Sarsaparilla E C
Most common in beech-maple forests, although very

common in cedar bogs, and in the Picea-Abies association, as well as in the aspens Cecil

ARALIA HISPIDA Vent Bristly Sarsaparilla E C

In the aspens, fireweed and bramble associations, common

276 APIACEAE (AMMIACEAE or UMBELLIFERAE) (Carrot Family)

SANICULA MARYLANDICA L Black Snake-root E C

Occasional in the gorge and in beech-maple forests

SANICULA GREGARIA Bicknell C

Occasional in cedar bogs

SANICULA TRIFOLIATA Bicknell C

In a beech-maple forest on Colonial Point

DAUCUS CAROTA L Wild Carrot E

As a ruderal, but rare Cultivated

WASHINGTONIA CLAYTONI (Michx) Britton (*Osmorhiza Claytoni* (Michx) Clarke) Hairy Sweet-Cicely E C

Occasional in beech-maple forests

WASHINGTONIA LONGISTYLIS (Torr) Britton (*Osmorhiza longistylis* (Torr) DC Smooth Sweet-Cicely E C

Occasional in beech-maple forests

WASHINGTONIA DIVARICATA Britton (*Osmorhiza divariata* Nutt) E

In a cedar bog west of Pellston

PASTINACA SATIVA L Wild Parsnip E C

Occasional in thickets along Maple River and along streams emptying into Burt Lake Cecil

HERACLEUM LANATUM Michx Cow Parsnip E * C

In the beech-maple forest on Colonial Point, rare

TAENIDIA INTEGERRIMA (L) Drude Yellow Pimpernel E C

In the beech-maple forest on Colonial Point and west of Cecil

HYDROCOTYLE UMBELLATA L Marsh Pennywort C

In a cedar bog along Trout Creek, 1915 (F T MacFarland)

CONIUM MACULATUM L Poison Hemlock E

Woodlot near Levering, 1920 (Ehlers)

SIUM CICUTAEFOLIUM Schrank Hemlock Water Parsnip E C
Occasional in marshes along streams, Bessey Creek, Maple River

CICUTA MACULATA L Cicuta E C
Meadows and thickets along streams, not common Cecil

CICUTA BULBIFERA L E C
Occasional, especially in burnt-over cedar bogs Cecil

277 CORNACEAE (Dogwood Family)

CORNUS RUGOSA Lam (*C circinata* L'Hér) Round-leaved Dogwood E C
Most abundant in the aspens, but occurs also in the tamarack, beech-maple and bramble associations Cecil

CORNUS AMOMUM Mill E * C
Sandy shores of Douglas Lake

CORNUS BAILEYI Coult & Evans E C
Occasional in thickets along the lake shores Big Stone Bay

CORNUS STOLONIFERA Michx Red-osier Dogwood E C
A dominant shrub in a thicket association and readily invading many wet-ground associations Common Cecil

CORNUS FEMINA Mill (*C paniculata* L'Hér) E * C
Occasional in the jack pine plains south of Burt Lake

CORNUS ALTERNIFOLIA L f E C
Occasional in beech-maple forests, or in the aspens following the burning of hardwoods 'West of Pellston

CHAMAEPERICLYMENUM CANADENSE (L) Asch & Graebn (*Cornus canadensis* L) E C
Very common in cedar bogs, especially along roads, but also rather plentiful in the beech-maple forest and in the aspens Cecil

278 RUBIACEAE (Madder Family)

MITCHELLA REPENS L Partridge-berry, Twin Berry E C
Generally distributed in forest associations especially the beech-maple and the Picea-Abies associations Cecil

GALIUM LANCFOLATUM Torr C
Occasional in beech-maple forests, Grapevine Point

GALIUM CIRCAEZANS Michx Wild Liquorice E * C
Occasional in thickets and in the beech-maple forest Grapevine Point

GALIUM BOREALE L Northern Bedstraw E C
In Myrica thickets west of Pellston and at Cecil Previous to the fire of 1914, at Smith's Bog

GALIUM TRIFLORUM Michx E C
Generally distributed in wooded areas, common

GALIUM TINCTORIUM L E * C
Rare in bogs

GALIUM LABRADORICUM Wiegand C
In Sphagnum at the Mud Lake Bog

GALIUM TRIFIDUM L Bedstraw E C
Frequent in various bog and wet-ground associations

GALIUM CLAYTONI Michx C
In a bog back from Sedge Point

GALIUM CONCINNUM Torr & Gray C
In a wooded area bordering Burt Lake

GALIUM ASPRELLUM Michx E
In a creek bottom west of Pellston

279 CAPRIFOLIACEAE (Honeysuckle Family)

SAMBUCUS CANADENSIS L Common Elder. E C
Not common, in willow-thickets along Maple River and Bessey Creek and in farm-yards Becoming more frequent Cecil

SAMBUCUS RACEMOSUS L Red-berried Elder E C
Abundant, in willow-thickets, brambles and suitable places in the beech-maple forest and in aspens Cecil

VIBURNUM OPULUS L (*V Opulus* L var *americanum* (Mill) Ait) Cranberry-tree E C
Occasional in bogs and willow-thickets along streams Cecil

VIBURNUM ACERIFOLIUM L Maple-leaved Arrow-wood E * C
Occasional in the aspens and in the gorge

VIBURNUM CASSINOIDES L E C
Abundant in thickets on the borders of bogs

VIBURNUM LENTAGO L Nanny-berry E C
Infrequent in rich soil along streams

LINNAEA AMERICANA Forbes (*L borealis americana* (Forbes) Rehder) Twin-flower E C
Abundant in cedar bogs, especially so in openings along roadways through them Cecil

LONICERA HIRSUTA Eaton Hairy Honeysuckle E * C
Occasional in bogs

LONICERA GLAUCESCENS Rydb E * C
Found in a cedar bog and in the beech-maple forest

LONICERA DIOICA L E C
In thickets and bogs along streams, common Cecil

LONICERA OBLONGIFOLIA (Goldie) Hook Swamp Fly-Honeysuckle E C
Occasional in bogs West of Pellston

LONICERA CANADENSIS Marsh American Fly-Honeysuckle E * C
Occasional in beech-maple woods and becoming more frequent in the aspens

LONICERA TATARICA L Bush Honeysuckle E
Cultivated shrub in Pellston

DIERVILLA DIERVILLA (L) MacM (*D Lonicera* Mill) Bush Honeysuckle E C
One of the most abundant species in the aspens, but occurring also in the beech-maple forest and in cedar bogs, with modified leaves in the shade Cecil

281 VALERIANACEAE (Valerian Family)

VALERIANA ULIGINOSA (T & G) Rybd E
Abundant in a tamarack-spruce-cedar bog west of Pellston

VALERIANA OFFICINALIS L Garden Valerian C
Cultivated in a yard along Burt Lake

283 Campanulaceae (Bellflower Family)

Campanula rotundifolia L Harebell E C
Common on dunes and in meadows in swales along Lake Michigan in Cecil and Big Stone bays Jack pine plains south of Burt Lake

Campanula rapunculoides L C
A few patches along roads in Riggsville and north of North Fishtail Bay

Campanula aparinoides Pursh Bedstraw Bellflower E C
Occasional in bog and marsh associations in the open

Campanula uliginosa Rydb E C
Infrequent in bog and marsh associations

Specularia perfoliata (L) A DC Venus' Looking-glass C
Infrequent in a field near Ingleside and along the state road in the aspens south of Camp Davis

Lobelia cardinalis L Cardinal Flower E C
In marsh associations in beach pools and along streams and persisting into thickets, frequent Cecil

Lobelia cardinalis alba C
A few plants in the Iris association along Maple River just west of its source in Douglas Lake

Lobelia siphilitica L Blue Lobelia E * C
Grassy areas near Bessey Creek and at the head of Burt Lake, infrequent

Lobelia spicata Lam C
Swampy area in the jack pine plains south of Burt Lake

Lobelia Kalmii L E C
Frequent in beach-pool associations Cecil

287–300 COMPOSITAE (Composite Family)

287 Helianthaceae

Silphium laciniatum L Compass Plant C
A few plants in a former garden along Burt Lake, brought in from Kansas several years ago, flourished during the life

of the settler (to 1916), but since has been gradually disappearing in competition with *Asclepias syriaca* and grasses

SILPHIUM TEREBINTHINACEUM Jacq C

A few plants in the same garden as the preceding and with the same status

HELIOPSIS SCABRA Dunal E C

A few stations along roadsides and in meadows West of Pellston and on Temperance Point

RUDBECKIA HIRTA L Black-Eyed Susan E C

In the aspens and along roads, becoming more frequent Cecil

HELIANTHUS ANNUUS L Common Sunflower E * C

Occasional along roads near farm houses As a weed in a corn field in 1918 and in an abandoned road in the center of Wolff's Bog in 1920

HELIANTHUS SCABERRIMUS Ell E

A few plants in a mill-yard in Pellston, 1917 (Gleason) Brutus

HELIANTHUS SUBRHOMBOIDEUS Rydb C

A fair-sized patch in an abandoned farm near Mud Lake

HELIANTHUS OCCIDENTALIS Riddell C

Rather common in the jack pine plains south of Burt Lake

HELIANTHUS MAXIMILIANI Schrad E

A few plants in a mill-yard in Pellston, 1917, also rare along roads

HELIANTHUS TUBEROSUS L Jerusalem Artichoke C

Occasional in the aspens on Grapevine Point

COREOPSIS LANCEOLATA L E

In marshy meadows around boggy areas west of Cecil and on established dunes westward Previous to 1918, abundant in a sandy clearing towards Big Stone Bay, but then destroyed by cultivation

BIDENS CERNUA L Bur Marigold E C

Fairly common in wet places

BIDENS CONNATA Muhl C

Occasional in wet places, especially beach pools

BIDENS COMOSA (A Gray) Wiegand E C
Occasional in wet places Stems sometimes partly purple

BIDENS FRONDOSA L Beggar-ticks, Stick-tight E
In wet places

BIDENS VULGATA Greene E C
In wet places, occasional as a fireweed in wet ground

MEGALODONTA BECKII (Torr) Greene (*Bidens Beckii* Torr) Water Marigold E C
Locally abundant in a few places in Maple River near its mouth and in Crooked River

288 AMBROSIACEAE

IVA XANTHIIFOLIA Nutt (*I xanthifolia* Nutt) E C
Local in at least three places near Levering, west of Pellston, near Lancaster Lake and Big Stone Bay

AMBROSIA TRIFIDA L Giant Ragweed E
Shore of Lake Michigan in Big Stone Bay near a dwelling

AMBROSIA ELATIOR L (*A artemisiaefolia* L) Ragweed E C
Ruderal and grain-field weed

AMBROSIA PSILOSTACHYA DC Western Ragweed E C
Infrequent, but locally abundant along roads and in fields

XANTHIUM SP? Cocklebur E
A few small plants near a hog-pen in Big Stone Bay, without flowers or fruit

289 HELENIACEAE

GAILLARDIA ARISTATA Pursh E C
Found in 1920 near Carp Lake (J H & L S Ehlers) Cultivated in Riggsville, 1923

287–300 COMPOSITAE (292 INULACEAE)

ANTENNARIA CANADENSIS Greene E C
Frequent in the aspens, especially in the drier places

ANTENNARIA PLANTAGINIFOLIA (L) Richards E * C
In the aspens, infrequent

ANTENNARIA NEODIOICA Greene E C
Frequent in the aspens, especially west of Douglas Lake

ANTENNARIA NEGLECTA Greene (including *A petaloidea* Fernald C
Found in 1915

ANAPHALIS MARGARITACEA (L) Benth and Hook Pearly Everlasting E C
Rather frequent, in brambles, the aspens and cedar bogs Cecil

GNAPHALIUM OBTUSIFOLIUM L (*G polycephalum* Michx) Fragrant Life Everlasting E C
Occasional in the aspens, jack pine plains south of Burt Lake and at Cecil

GNAPHALIUM DECURRENS Ives Clammy Everlasting E C
Frequent in the aspens

GNAPHALIUM ULIGINOSUM L E C
Along roads through bogs or in other wet places in burnt-over areas Cecil

INULA HELENIUM L C
A patch along a road west of Lancaster Lake

293 ASTERACEAE

GRINDELIA SQUARROSA (Pursh) Dunal Tarweed E C
About a dozen clumps along a road east of Pellston in 1920, spreading extensively eastward along that road, a few plants in a field bordering the east side of Lancaster Lake, 1923 (J H Ehlers)

SOLIDAGO CAESIA L E * C
Beech-maple forest on Colonial Point

SOLIDAGO FLEXICAULIS L (*S latifolia* L) Goldenrod E * C
Occasional in the beech-maple forest

SOLIDAGO HISPIDA Muhl E C
Very common in the aspens Cecil

SOLIDAGO ULIGINOSA Nutt Bog Goldenrod E C
Local in tamarack and cedar bogs Mud Lake and Cecil

SOLIDAGO RIGIDIUSCULA (T & G) Porter (*S speciosa* var *angustata* T & G) C

Common on the jack pine plains south of Burt Lake

SOLIDAGO GILLMANI (A Gray) Steele (*S racemosa* var *gillmani* (Gray) Fernald) E

On dunes along Lake Michigan in the Big Stone Bay region

SOLIDAGO RUGOSA Mill E C

Mostly in burnt parts of cedar bogs, especially along roads in such places Gorge, Cecil Var *villosa* (Pursh) Fernald in a swamp in the jack pine planes south of Burt Lake

SOLIDAGO JUNCEA Aiton E * C

In the aspens westward of Camp Davis and on the jack pine plains south of Burt Lake

SOLIDAGO CANADENSIS L E C

Common as a fireweed, occurring also in associations of dry sandy land, especially in the aspens and in the brambles Occasional as a ruderal Cecil

SOLIDAGO SEROTINA Ait E * C

In the Iris association along Maple River

SOLIDAGO ALTISSIMA L E * C

In the Iris association along Maple River

SOLIDAGO NEMORALIS Ait E * C

Common on the jack pine plains south of Burt Lake, occasional in the pine land southeast of Bryant's

SOLIDAGO OHIOENSIS Riddell E

Common in the marshy meadows bordering boggy areas just west of Cecil Big Stone Bay

SOLIDAGO HOUGHTONII T & G E

Swamps in Big Stone Bay

EUTHAMIA GRAMINIFOLIA (L) Nutt (*Solidago graminifolia* (L) Salisb) E C

Common in Myrica and willow-thickets and in a few of the wet beach associations, as the *Scirpus americanus* Cecil

ASTER MACROPHYLLUS L Large-leaved Aster E C

Beech-maple forest, aspens, and cedar bogs Cecil and Big Stone Bay region, abundant Var *sejunctus* Burgess occurs in the Burt Lake beech-maple forests

ASTER NOVAE-ANGLIAE L E * C
Occasional as a fireweed and in willow-thickets

ASTER PUNICEUS L E C
In cedar bogs, in openings and in roadside ditches

ASTER LAEVIS L Smooth Aster E C
A very common secondary species in the aspens Cecil

ASTER JUNCEUS Ait Rush Aster E C
Common in bogs and other wet-ground associations along lakes and streams Cecil

ASTER LATERIFLORUS (L) Britton E C
Occasional in wet ground in ditches, along streams and in bogs Cecil

ASTER HIRSUTICAULIS Lindl (A *lateriflorus* var *hirsuticaulis* (Lindl) Porter) C
Wet ground near Munro Lake

ASTER MULTIFLORUS Ait C
In a roadside ditch in North Fishtail Bay

ASTER TRADESCANTI L E * C
Occasional in wet ground

ERIGERON PULCHELLUS Michx C
Found in a burnt-over cedar bog in 1911 (Gates)

ERIGERON PHILADELPHICUS L Philadelphia Fleabane E C
As a ruderal and common in many wet-ground associations Cecil

ERIGERON ANNUUS (L) Pers Daisy Fleabane E * C
A ruderal, occasional

ERIGERON RAMOSUS (Walt) B S P E C
A common ruderal and frequent in the aspens

LEPTILON CANADENSE (L) Britton (*Erigeron canadensis* L) Horseweed E C
A common fireweed, also very abundant in the aspens

295 EUPATORIACEAE

EUPATORIUM MACULATUM L (*E purpureum* var *maculatum* (L) Darl) E C
A dominant species in the Iris association, occasionally very abundant, as at the source of Bessey Creek

EUPATORIUM PURPUREUM L Joe-pye Weed E C
A dominant species in the Iris association and occurring in many other associations of wet ground, including thickets and cedar bogs Cecil

EUPATORIUM PERFOLIATUM L Boneset E C
Dominant in the Iris association, but occurring in many of the other wet-ground associations, as well as in some bramble areas Common Cecil

LACINARIA CYLINDRACEA (Michx) Kuntze (*Liatris cylindracea* Michx) Blazing Star C
Locally abundant on the jack pine plains south of Burt Lake

296 ANTHEMIDACEAE

ACHILLEA MILLEFOLIUM L Yarrow E C
A common ruderal and common in the aspens Cecil Flowers infrequently pink

ANTHEMIS COTULA L Mayweed E C
Ruderal Cecil

ANTHEMIS ARVENSIS L C
A few plants along a road near a farm-house east of North Fishtail

CHRYSANTHEMUM LEUCANTHEMUM L (*C Leucanthemum* var *pinnatifidum* Lecoq & Lamotte) Ox-eye Daisy E C
Ruderal and frequent in the aspens Cecil

CHRYSANTHEMUM PARTHENIUM (L) Pers Feverfew C
Roadside between Munro and Mud lakes

CHRYSANTHEMUM BALSAMITA L (*C Balsamita* var *tanacetoides* Boiss) Mint Geranium C
Roadsides, usually in the vicinity of farm-houses

TANACETUM VULGARE L Tansy E * C
Local along roads in the vicinity of farm-houses, infrequent Colonial Point

TANACETUM HURONENSE Nutt E
Common on sand-dunes along Lake Michigan in Cecil and Big Stone bays

ARTEMISIA CAUDATA Michx E
Common on dunes along Lake Michigan in Cecil and Big Stone bays

ARTEMISIA ABSINTHIUM L Absinth E * C
Roadsides

ARTEMISIA ANNUA L Wormwood E
Collected in the mill-yard in Pellston, 1917 (H A Gleason)

ARTEMISIA BIENNIS Willd E
Roadsides west of Pellston Big Stone Bay

ARTEMISIA STELLERIANA Bess E
Cultivated in a garden in Pellston and persisting after abandonment

ARTEMISIA VULGARIS L Common Mugwort C
A patch along a road near Mud Lake

297 SENECIONIDACEAE

PETASITES PALMATA (Ait) Gray E C
A few plants in Reese's Bog, Riggsville Bog, west of Lancaster Lake and west of Pellston, but more common along boggy areas and in pine woods west of Cecil

ERECHTITES HIERACIFOLIA (L) Raf Fireweed E C
A common fireweed, but quite local in its distribution, most frequently found following burns of beech-maple forests Cecil

SENECIO AUREUS L Golden Ragwort E C
In a ditch along the railroad near Cecil and along Carp Creek in the gorge

SENECIO PAUPERCULUS Michx (*Senecio balsamitae* Muhl) E C
Occasional in the aspens, best developed in low spots Specimens in dry years approach *S plattensis* Nutt

298 CARDUACEAE

ARCTIUM MINUS Schk (*Arctium minus* (Hill) Bernh) Burdock. E C
Ruderal and farm-yard weed, rarely in the aspens Cecil

CIRSIUM LANCEOLATUM (L) Hill Common Thistle E C
A ruderal, not common Cecil

CIRSIUM PITCHERI (Torr) T & G E C
Fairly common and characteristic of Ammophila dunes and infrequently on the strand in Cecil and Big Stone bays

CIRSIUM UNDULATUM (Nutt) Spreng E
A few plants in the mill-yard in Pellston, 1917 (H A Gleason)

CIRSIUM HILLII (Canby) Fernald C
On the jack pine plains south of Burt Lake

CIRSIUM MUTICUM Michx Swamp Thistle E C
Occasional in wet places in the bramble association, but more commonly along streams through cedar bogs, or through willow-thickets, gorge Cecil

CIRSIUM ARVENSE (L) Scop Canada Thistle E C
A ruderal and in the aspens, becoming locally abundant White-flowered plants have been found Cecil

300 LACTUCACEAE

CICHORIUM INTYBUS L Chicory E C
A ruderal becoming more frequent in the vicinity of farm-houses, Riggsville, Cheboygan, etc Cecil

TRAGOPOGON PRATENSIS L Yellow Salsify E C
Ruderal, Pellston, east side of Burt Lake, infrequent

TRAGOPOGON PORRIFOLIUS L Purple Oyster Plant E C
A ruderal, east side of Burt Lake, rare

TARAXACUM VULGARE (Lam) Schrank (*T officinale* Weber, *Leontodon Taraxacum* L) Dandelion E C
Ruderal, etc Fairly common in the aspens Cecil

SONCHUS ASPER (L) Hill Sow-thistle E C
Ruderal and farm-yard weed, infrequent

LACTUCA VIROSA L (*Lactuca scariola* L) Prickly Lettuce E * C
Ruderal, uncommon

LACTUCA VIROSA INTEGRATA Gren & Godr C
Ruderal and a field weed, not common

LACTUCA CANADENSIS L Wild Lettuce E C

A common ruderal and rather abundant in the aspens Also as a fireweed Cecil

LACTUCA SAGITTIFOLIA Ell (*L integrifolia* Bigel) E * C

Occasional as a ruderal and a fireweed

LACTUCA PULCHELLA (Pursh) DC C

Found by Gleason in 1911, ruderal

LACTUCA SPICATA (Lam) Hitchcock Tall Blue Lettuce E * C

Occasional in beech-maple forests, tamarack and cedar bogs Var INTEGRIFOLIA (A Gray) Britton occurs in a beech-maple forest

HIERACIUM CANADENSE Michx Hawkweed E * C

Fairly frequent in the aspens

HIERACIUM PANICULATUM L C

Infrequent in the aspens — the plants with glandular pedicels

HIERACIUM SCABRUM Michx E C

Fairly common in the aspens and in thickets

HIERACIUM GRONOVII L C

Rare, in the aspens

HIERACIUM VENOSUM L E C

An abundant secondary species in the aspens Cecil

HIERACIUM PRATENSE Tausch Field Hawkweed C

Three plants found by F M Loew in a beech-maple area in 1911

HIERACIUM AURANTIACUM L Orange Hawkweed E C

Occasional along roads and in the aspens on the better soils, whether upland or lowland Becoming more common More conspicuous some years than others

NABALUS ALBUS (L) Hook (*Prenanthes alba* L) Rattlesnake-root E * C

Infrequent on low ground in thickets

NABALUS RACEMOSUS (Michx) DC (*Prenanthes racemosa* Michx) E C

Occasional in the aspens In low ground west of Cecil Colonial Point

BIBLIOGRAPHY OF THE FLORA OF THE DOUGLAS LAKE REGION

(In the bibliography which follows we have included, for the sake of completeness and convenience of reference, not only the papers pertaining to the higher plants, but also those pertaining to the lower cryptogams, although the latter plants are not included in the list)

BONAR, LEE 1918 The Rusts of the Douglas Lake Region Report Mich Acad Sci, 20 277–278

EHLERS, J H 1921 *Panicum virgatum*, var *cubense* in Michigan Rhodora, 23 200

FALLASS, CHARLES W, AND SWIFT, CHARLES H A List of Plants (Pteridophytes, Gymnosperms and Angiosperms) Found in Emmet County, Michigan (*Unpublished*)

GATES, F C 1911 An Addition to the Description of *Streptopus longipes*, Fernald Rhodora, 13 237

—— 1912 The Vegetation of the Region in the Vicinity of Douglas Lake, Cheboygan County, Michigan, 1911 Report Mich Acad Sci, 14 46–106 Pls V–XXI

—— 1922 Extensions of Range of Plants in the Douglas Lake Region, Cheboygan County, Michigan Papers of the Mich Acad of Sci, Arts and Letters, 2 47–48

—— The Vegetation of the Region of Douglas Lake, Michigan (*In preparation*)

GLEASON, HENRY ALLEN 1913 Some Interesting Plants from the Vicinity of Douglas Lake Report Mich Acad Sci, 15 147–149

—— 1918 Notes on the Introduced Flora of the Douglas Lake Region Report Mich Acad Sci, 20 153 (*Abstract*)

—— 1918 Local Distribution of Introduced Species near Douglas Lake, Michigan Torreya, 18 81–89

GLEASON, HENRY ALLEN, AND MCFARLAND, FRANK T 1914 The Introduced Vegetation in the Vicinity of Douglas Lake, Mich Bull Torrey Bot Club, 41 511–521

HARPER, ROLAND M 1914 Car-window Notes on the Vegetation of the Upper Peninsula (of Michigan) Report Mich Acad Sci, 15 193–198

—— 1918 The Plant Population of Northern Lower Michigan and its Environment Bull Torrey Bot Club, 45 23–42

HOLMAN, R M, AND REED, E 1918 Notes on the Phytoplankton and Other Algae of Douglas Lake and Vicinity Report Mich Acad. Sci, 20 153–154 (*Abstract*)

McFarland, Frank T 1916 The Ferns and their Distribution at Douglas Lake, Mich Amer Fern Journ, 6 106–112

Nichols, G E 1922 The Bryophytes of Michigan with Particular Reference to the Douglas Lake Region The Bryologist, 25 41–58 May, 1922

Praeger, W E 1919 A Collection of Sphagnales from Douglas Lake Report Mich Acad Sci, 21 237–238, 1919

Transeau, Edgar N 1917 The Algae of Michigan The Ohio Journ of Sci, 17 217–232

THE STRUCTURE OF THE MAPLE-BEECH ASSOCIATION IN NORTHERN MICHIGAN

HENRY ALLAN GLEASON

INTRODUCTION

THE northern part of the Lower Peninsula of Michigan was originally occupied chiefly by two plant associations, the one characterized by Norway pine and white pine, and the other by sugar maple and beech Only a small proportion of the area was held by the numerous minor associations which constitute the varied vegetation of bogs, swamps, shores, and dunes Of these two important associations, the pine forest was composed chiefly of northern species, which in this region were near or at their southern limit, while the hardwood forest of beech, elm, basswood, sugar maple, and other deciduous trees included chiefly southern species, which found their northern limit of distribution here or a comparatively short distance farther north

Abundant evidence has been brought forward to show that the pine forests are a part of a great series of associations which have been closely related to one another since pre-glacial time, which are connected by certain definite successional trends, and which occupy the same general range, extending in a broad belt across the continent from Alaska to Newfoundland The hardwood forest is, similarly, a part of another great vegetation-complex, occupying most of the land between the Missouri Valley and the Atlantic Ocean and between the Great Lakes and the southern end of the Appalachian Mountain system It has also been shown for this portion of Michigan, and the same condition is doubtless true for many other regions as well, that there is great competition between the various associations of these two complexes wherever they come in contact, and that

in general the associations of the southern complex tend to displace those of the northern This was early demonstrated by Whitford (1901) and needs no further discussion here Again, it seems entirely probable that this present tendency is only the continuation of a similar competition between the two types of vegetation which has existed since shortly after the close of the last glacial period, the general result of which (Gleason, 1923) has been the retreat northward of the pine forests and the associations related to them for some three hundred or four hundred miles and the corresponding advance of the hardwood forest for the same distance

Numerous papers have appeared during the past two decades dealing with the general ecology and distribution of these two types of vegetation Two of the more recent are those by Clayberg (1920), who well describes the environment and the life-history of the maple-beech forest and its relations to the other associations of the region, and by Quick (1924), who discusses the general distribution of the association throughout the Lower Peninsula of Michigan Both authors cite the important earlier papers in their bibliographies

No paper, however, has so far presented a full statement of the floristic structure of this exceedingly important association Since it is rapidly disappearing before the encroachment of the lumberman, it seems highly desirable to put on record an account of the component species and of their relative importance During the summer of 1923, the writer accompanied Dr Lee R Dice, of the Zoölogical Museum of the University of Michigan, on a reconnaissance of some large tracts of virgin maple-beech forest, and to the observations made then he has added others made by him at various times and places in the same general region

AREAS EXAMINED

1 A square mile of virgin forest on Section 13, Town 30 North, Range 5 West, in the extreme eastern end of Antrim County, bordering on Otsego County, about six miles east of

Alba The whole surface is essentially flat and without surface drainage, soil sandy, allowing easy percolation of rain water, altitude about 1200 feet

2 A square mile on Section 8, Town 30 North, Range 4 West, near the western end of Otsego County, about two miles northeast of Area 1 and with the same topography and soil

3 A square mile on Section 17, Town 30 North, Range 4 West, in Otsego County, adjoining Area 2 on the south and with the same topography and soil

4 A tract almost a square mile in extent on Section 35, Town 32 North, Range 4 West, in the eastern end of Charlevoix County, about eight miles north of Area 2 The surface is rolling, freely traversed by narrow ravines with gently sloping sides which carry flood waters only, soil sandy, altitude probably about 1000 feet and distinctly lower than the high morainic hills of the vicinity

5 A small tract, not exceeding forty acres in extent, on the land of the State Game Refuge in Emmet County, about nine miles southwest of Mackinaw City, on an old beach of Lake Nipissing, soil sandy, surface level, altitude about 650 feet The area is completely surrounded by coniferous forest, composed chiefly of arbor-vitae and balsam on the low ground of the same general level and of pine on the adjoining high fossil dunes

METHOD

The composition of the dominant forest layer was determined by counting all the trees six inches or more in diameter on a strip about fifty feet wide extending across the area, and the results are here expressed in percentages The frequency of the secondary species, including the herbs, shrubs, and seedling trees, was determined by listing every species in each of 100 quadrats one meter square The results of this count are expressed by a percentage known as the frequency index, showing the percentage of the total quadrats examined (in this case 100 in each area) in which the species actually occurs The quadrats were located in a strip, spaced ten paces apart, and the strip

is accordingly 1000 paces long, extending across the area, or back and forth in the small Area 5. Quadrats were in every case counted where they lay, no matter what might be the local conditions on each. Thus some were largely occupied by large trees, others by fallen logs, and others by dense thickets of shrubbery. Determination of the frequency index by this method is of course impartial: it indicates the important species, expresses the relative importance and commonness of each, and gives a basis of data upon which the total number of species may be calculated with a high degree of accuracy. In addition to these statistical observations, all other species of vascular plants were listed so far as noted.

In every plant association of considerable age and general uniformity of environment, of which the maple-beech forest is an excellent illustration, the vegetation attains also a great uniformity. A hundred quadrats, scattered widely over an area, are sure to include all the typical species and the frequency index shows their relative importance. Other species of minor importance may be represented by so few individuals that they are not included in any of the quadrats, but are noted elsewhere, while still others may escape attention completely unless every square foot of the area is searched. The number of these unobserved species may be estimated with great accuracy, since the increase in number of species from small tracts to large varies as the logarithm of the area.

In the following tables, the frequency index of each species is expressed in figures, the presence of a species outside the quadrats is indicated by *x*, and blanks indicate that the species was not observed in the area. The first table refers only to trees more than six inches in diameter, while reference to trees in the second table pertains only to seedlings and saplings. Scientific names follow the usage of Gray's *New Manual of Botany*, with the exception of certain species of Carex, for the identification of which the writer is under obligations to Mrs. John H. Ehlers.

TABLE I

COMPOSITION OF THE FOREST COVER

SPECIES	AREA			
	1	2	3	4
Acer Saccharum	91	75	75	48
Betula lutea	4	1	4	x
Fagus grandifolia	x	1	5	28
Ostrya virginiana		x	1	
Tilia americana	1	4	1	1
Tsuga canadensis	x	1	5	3
Ulmus americana	4	18	9	20

TABLE II

FREQUENCY INDEX OF SECONDARY SPECIES

A SPECIES NORMALLY ASSOCIATED WITH THE MAPLE-BEECH ASSOCIATION

SPECIES	AREA				
	1	2	3	4	5
Acer Saccharum	100	100	100	100	100
Acer spicatum	3	9	5	10	
Actaea alba	x	x			3
Adiantum pedatum	1	4	x	9	
Aralia nudicaulis	20	36	45	24	4
Aralia racemosa	x		x	1	
Arisaema triphyllum	x	8	x	13	
Asarum canadense				1	
Aspidium spinulosum	44	41	67	38	
Betula lutea	3	x	x	1	3
Botrychium virginianum	1				x
Brachyelytrum erectum	x		1		
Carex arctata	1		4	3	
Carex convoluta				x	
Carex intumescens	4	3	1	x	
Carex laxiflora latifolia				x	
Carex leptonervia			1		2

TABLE II — *Continued*

FREQUENCY INDEX OF SECONDARY SPECIES

A SPECIES NORMALLY ASSOCIATED WITH THE MAPLE-BEECH ASSOCIATION

SPECIES	AREA 1	2	3	4	5
Caulophyllum thalictroides	x	x	x	x	
Cornus alternifolia	1	1	x	x	
Corylus rostrata		x	1		
Cystopteris fragilis			1	x	x
Fagus grandifolia	x	2	5	70	14
Fraxinus americana				3	
Galium triflorum	11	22	7	20	x
Geranium Robertianum		7	x	2	
Hepatica acutiloba				2	
Melica Smithii		1	x	5	
Milium effusum	3	8	11	3	
Mitella diphylla				x	
Monotropa uniflora					1
Osmorhiza Claytoni	10	51	3	78	1
Ostrya virginiana		x	x	x	
Oxalis Acetosella			x		
Polygonatum biflorum	18	8	10	8	
Psedera quinquefolia				3	
Ribes Cynosbati	4	8	2	1	
Sambucus racemosa	9	32	9	23	
Smilacina racemosa	x	2	2	5	13
Streptopus roseus	3	x	6		
Thalictrum dioicum	x				
Tiarella cordifolia	59	50	40	20	
Tilia americana	2	3	1	2	
Trillium grandiflorum	3	x	5	7	3
Ulmus americana	22	21	23	18	
Ulmus fulva	x				
Viburnum acerifolium	1	x			
Viola scabriuscula	28	59	13	41	

TABLE II — *Continued*

B SPECIES NORMALLY ASSOCIATED WITH CONIFEROUS FORESTS, EITHER OF BOG OR OF UPLAND

SPECIES	AREA 1	2	3	4	5
Abies balsamea					x
Aster macrophyllus			1		x
Circaea intermedia		1		1	
Clintonia borealis			x		1
Cornus canadensis					x
Lonicera canadensis	1	1	4	x	4
Lycopodium annotinum					12
Maianthemum canadense	2	3	14	5	13
Mitchella repens	2	3	5	5	35
Pinus Strobus			x		
Pyrola americana					x
Pyrola secunda					4
Streptopus amplexifolius	x				
Taxus canadensis	x	6	2	x	25
Trientalis americana	2		4		41
Trillium cernuum	x				

C SPECIES NORMALLY ASSOCIATED WITH THE ASPEN FOREST

SPECIES	AREA 1	2	3	4	5
Acer pennsylvanicum				x	14
Acer rubrum	x				
Diervilla Lonicera			1		
Hamamelis virginiana			x		
Lactuca spicata	x	x		x	
Oryzopsis asperifolia			x		
Polygonum cilinode		x			
Prunus virginiana	1		x	x	x
Rubus allegheniensis	4	2	21		
Rubus idaeus aculeatissimus		16			

TABLE II — *Concluded*

D MISCELLANEOUS OR UNIDENTIFIED SPECIES

SPECIES	AREA				
	1	2	3	4	5
Asplenium filix-femina					x
Carex sp					x
Corallorhiza sp					x
Prunus serotina	x	x	2		
Viola sp	10	9	1		x

GENERAL DISCUSSION

A survey of the preceding tables reveals some interesting conditions and enables us to draw certain conclusions respecting the ecology of this association A summary of the statistical matter may first be presented The total number of species observed is 79, of which 78 occur as secondary species in the ground cover, and 7 are trees which at maturity form the forest cover Other species of trees are represented, of which mature individuals were not observed Hemlock is the single arborescent species of which young plants were not detected

The average number of secondary species per meter quadrat is 2 93 in Area 5, and varies from' 3 73 to 5 17 in Areas 1 to 4 The probable total number of species for a square mile of the association is computed to range from 84 in Area 1 to 100 in Area 3, and the total flora of the association in the northern part of the Lower Peninsula probably does not exceed 200 species, excluding those recently introduced as a result of grazing, partial clearing, occasional fires, or other human activities

The allotment of species among the four ecological groups may be open to criticism As they stand, however, the first, containing the species considered to be normal to the maple-beech association, includes 23 species represented in four or all of the five areas, and 24 species limited to three areas or fewer Groups B and C, containing the casual species, include only five

of general distribution through four or all of the areas, and 21 restricted to three areas or fewer, and two-thirds of these are reported from a single area only The average frequency index of the species in Group A is 13, Group B, 5, Group C, 3, Group D, 2 Within Group A, those species which are represented in four or five areas have an average frequency of 18, which sinks to 1 for the species limited to three or fewer areas

Twenty-three species are accordingly indicated by the tables as the characteristic species of the association, distinguished not only by wide distribution among the areas, but also by high frequency indexes within the areas These species are as follows

TREES

Acer Saccharum	Tilia americana
Betula lutea	Ulmus americana
Fagus grandifolia	

SHRUBS

Acer spicatum	Ribes Cynosbati
Cornus alternifolia	Sambucus racemosa

HERBS

Adiantum pedatum	Milium effusum
Aralia nudicaulis	Osmorhiza Claytoni
Arisaema triphyllum	Polygonatum biflorum
Aspidium spinulosum	Smilacina racemosa
Carex intumescens	Tiarella cordifolia
Caulophyllum thalictroides	Trillium grandiflorum
Galium triflorum	Viola scabriuscula

It is probable that other prevernal species belong in this category, but these plants had completed their vegetative cycle and disappeared above ground before August, when this survey was made

A high frequency index necessarily requires a large number of individuals, and it is generally true that the number of individuals of any species is an indication of the degree of its adaption to the environment These twenty-three species are accordingly distinguished, in general, as the ones best fitted to live and multiply in the prevailing environment and under the strenuous competition of the maple-beech forest Some of them have a uniformly high frequency index, as *Acer Saccharum*, *Aspidium spinulosum*,

and *Tiarella cordifolia*, others are very constant in their abundance, as *Ulmus americana*, but a few show striking variations in frequency, as *Osmorhiza Claytoni* and *Fagus grandifolia* In the latter cases, the variation is too great to be ascribed merely to chance, and a causal difference in environment is suggested The nature of these environmental differences, if they exist, cannot be accurately determined except by experimental methods, but there is good reason, in the case of *Fagus grandifolia* at least, for believing that soil moisture is the controlling factor

In Areas 1, 2, and 3 the terrain is high and level Rain-water percolates into the ground at once and doubtless reaches a considerable depth, later to emerge in springs around the margin of the plateau on which these areas are situated In these three areas beech is relatively rare, especially in the seedling stage But in Area 4, situated on rolling ground at a lower elevation and probably better supplied by water by seepage, seedling beech is abundant and mature trees constitute a considerable part of the forest In a tract of hardwoods on the northwest shore of Burt Lake, where subterranean water seeps out into several boggy spots, mature beeches constitute 42 per cent of the forest, and the frequency index of seedlings rises to 43 Along a bluff west of Douglas Lake, now cleared, beech originally composed 28 per cent of the forest cover During the dry summer of 1923, it was very evident that beech seedlings were suffering from drought in the first three areas, while in Area 4 they showed no sign of such injury It is probably safe to conclude that the proportion of beech in the association depends chiefly on the amount of available water

Hemlock is present in all five areas in a small and rather variable amount, but hemlock seedlings were not observed Records by Dr Frank C Gates or by the writer, extending over a period of thirteen years at the Biological Station of the University of Michigan in Cheboygan County, indicate that reproduction of hemlock is very rare, and the general deficiency of hemlock saplings shows that this condition has prevailed for many years Almost all hemlock trees in the hardwood forests of the region are veterans After their death, which may be

expected in a comparatively short time, hemlock will practically disappear as a component of the association On the other hand, conditions were undoubtedly favorable for the establishment of hemlock some three centuries ago, when the present veterans were seedlings Such a period is too short to expect any fundamental climatic variation to have taken place, and it is more plausible to assume tentatively that the chief environmental change has been caused by the vegetation itself The forest cover has a great effect on the environment of the ground vegetation, through its control of light, through its effect on the physical nature of the soil by the addition of fallen vegetable matter and the chemical nature by the decomposition of twigs and leaves, and through its control of the soil fauna and flora Whatever the vegetation of three hundred years ago may have been, it evidently produced an environment in which hemlock seeds could germinate and grow, and that is not true of the present forest cover of maple and beech

If the general successional relations of the coniferous and deciduous forests, as described by Whitford, are conceded, it follows that, in general, the youngest part of the deciduous forest is near its margin where it comes in contact with the earlier coniferous associations, and that small detached bodies of hardwood are generally younger than those of large extent Areas 1 to 3 are all parts of a great body of maple-beech forest which originally covered many square miles of land without interruption, while Area 5 is a small detached body, several miles from the nearest forest of the same type In Area 2 for example, there are 30 species assigned to Group A, species characteristic of the hardwood association, with an average frequency index of 16, and only five species of Group B, including those normal to coniferous forests, with an average frequency index of 3 In Area 5, Group A is represented by only 13 species, with an average frequency of 11, while Group B has 12 species with an average frequency of 11 The contrast between the two areas, as shown by these figures, is striking, and may well indicate that Area 2 is considerably older than Area 5, either ecologically or chronologically, and perhaps both

There is other ecological evidence, largely of a circumstantial nature, pointing to the same conclusion, which may be expressed by the following general theory The hemlock forest represents the mesophytic climax of various successional series of the northern type of vegetation, and the veteran hemlocks of the modern hardwood forest are the last generation of trees of this earlier association Succession by hardwood forests is a modern process, which in some places has not yet been completed in respect to the secondary species, and the present veteran trees of sugar maple and beech represent, in some places at least, the first generation of dominant species of this association

GENERAL CONCLUSIONS

1 The hardwood forest of the region is dominated by sugar maple, with beech, birch, elm, and basswood as important co-dominants, the proportions of each depending on the available moisture

2 The flora of the association includes some two hundred species of vascular plants, of which about a score are regarded as characteristic, and of which many others are chance invaders from neighboring associations or relicts of an earlier occupation of the land by coniferous forest Hemlock belongs in the latter category

3 The hardwood forest is still young historically and may have attained its full ecological dominance only one generation (about three centuries) ago

New York Botanical Garden

LITERATURE CITED

Clayberg, H D 1920 Upland Societies of Petoskey-Walloon Lake Region. Bot Gaz, 69 28–53 1 fig

Gleason, H A 1923 The Vegetational History of the Middle West Annals Assn Amer Geogr, 12 39–85

Quick, B E 1924 A Comparative Study of the Distribution of the Climax Association in Southern Michigan Papers Mich Acad Sci, 3 211–244 Pl XX

Whitford, H N 1901 The Genetic Development of the Forests of Northern Michigan, A Study in Physiographic Ecology Bot Gaz, 31 289–325 Figs 1–18

AN ECOLOGICAL STUDY OF MUD LAKE BOG, CHEBOYGAN COUNTY, MICHIGAN *

LOUISE GOE, ELSIE ERICKSON AND EDITH WOOLLETT

MUD LAKE is a small peat bog lake in the northwestern part of Inverness Township, Cheboygan County, Michigan (See Map II) The lake itself is about one fifth of a mile wide and approximately twice as long (Fig 4) The greatest depth is

FIG 4 General View of Mud Lake Bog from the Southeast
August 1921 Perry A Glick

* A contribution from the Biological Station of the University of Michigan

The work at Mud Lake was done under the direction and supervision

twenty-two feet The shortest distance to sand is eight feet The lake itself is alkaline while the surrounding mat is decidedly acid (See Table) It has a small stream flowing into it at the southeast side and an outlet, with no perceptible current, excepting in times of high water, at the northwest side The bog forest at the northwest continues for two miles, where it joins the bog forest extending up from Carp Lake, Although the bog evidently drains into Carp Lake, there is no perceptible stream flowing from one bog to the other, so that most of the drainage is probably due to seepage

The open water of the lake is surrounded by a quaking mat of vegetation Much of the mat is made up of *Sphagnum spp* The *Carex filiformis*,[1] Iris-Aspidium and Chamaedaphne associations are also present on the mat The mat varies in width from one or two feet to a quarter of a mile It also varies in stability In some places it is fairly dry and level, but more often it is hummocky and spongy, with very wet areas in the depressions

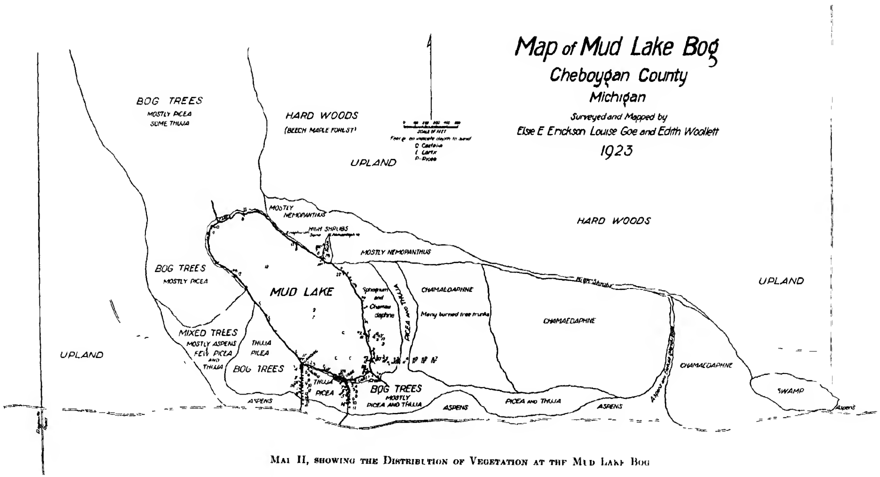
At the outer edge of the mat the high shrub zone is present and is dominated by the Nemopanthus-Alnus consocies of the high bog shrub association The best examples of the high shrub zone are found at the north side of the lake, where the shrubs are very numerous and grow close together

Beyond the high shrub zone is the lowland Thuja-Picea-Larix forest. On the higher, better drained land adjoining, trees such as *Acer saccharum*, *Fagus grandifolia*, *Acer rubrum* and *Ostrya virginiana* are found

While there are a few examples of pure associations, as a

of Dr F C Gates while the authors were enrolled as students at the University of Michigan Biological Station, Cheboygan County, Michigan It was begun during the summer of 1922 by Louise Goe and was continued during the summer of 1923 by Louise Goe, Elsie Erickson and Edith Woollett. Elsie Erickson was primarily responsible for the map, Edith Woollett for the peat readings, and Louise Goe for the general ecological description, although the three authors are jointly responsible for the entire paper

[1] The nomenclature is that of Gray's *New Manual of Botany*, seventh edition



MAP II, SHOWING THE DISTRIBUTION OF VEGETATION AT THE MUD LAKE BOG

general thing there is more or less of an intermingling, and many species present in an association may not belong there, but may be either invaders or relicts This is especially true in the Iris association Since the fires, *Typha latifolia* has invaded this association until the Iris has been crowded out In 1921 there was still a little left, but in 1922 it had completely disappeared (Fig 5)

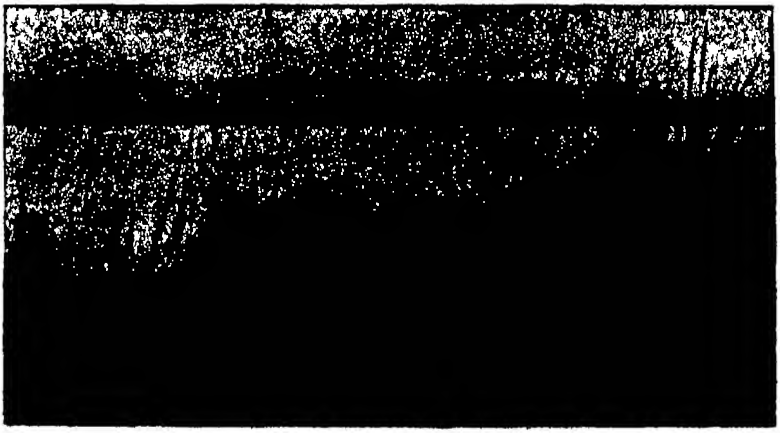


FIG 5. South Shore of Mud Lake, showing *Aspidium thelypteris*, *Typha latifolia*, *Carex spp* and *Calamagrostis inexpansa*
July, 1922 Louise Goe

Fires of various degrees of severity have burned over most of the bog, but the latest severe one was in 1916 The worst burning in this fire was at the northeast and east sides of the lake Dead trees and charred stumps still remain in large numbers Between the hummocks caused by the roots of dead trees are large areas of *Polytrichum juniperinum*, a condition which also indicates severe burning Fires have burned through at the southeast side where the mat is very wide and also on the west side Because of its natural protection the south side of the lake is practically untouched (Fig 6) There the mat is very narrow, in some places almost non-existent, and the trees

extend to the water's edge After the fires retrogression has taken place and in many places *Eriophorum viridi-carinatum* or *Eriophorum virginicum* may be very abundant

FIG 6 General View of the Southern Edge of Mud Lake
July 1916 F C Gates

At the northeast, east, south and west sides of the lake, beyond the bog forest, is higher land where aspens and fireweed are abundant

The vegetation of the Mud Lake Bog may be divided according to habitat into the following natural divisions

A OPEN WATER
 1 Chara-Potamogeton Association
 2 Castalia-Nymphaea Association

B MAT
 1 *Carex filiformis* Association
 2 Iris-Aspidium Association
 3 Chamaedaphne Association

C HIGH SHRUBS
 1 Nemopanthus-Alnus consocies of the high bog shrub Association

D BOG FOREST
 1 Larix-Picea-Thuja Association

The lake has a very even shore-line which is practically unbroken for a number of feet at a time There is a false bottom

which varies from two or three inches below the surface of the water to about a foot and a half It is composed of decaying vegetation and is quite easily disturbed The depth of the water above it depends upon the season and the amount of rain During the summer of 1921 the water was so low that a large part of it was exposed at the south end of the lake (Fig 7) In 1922 and 1923 the entire false bottom was under water

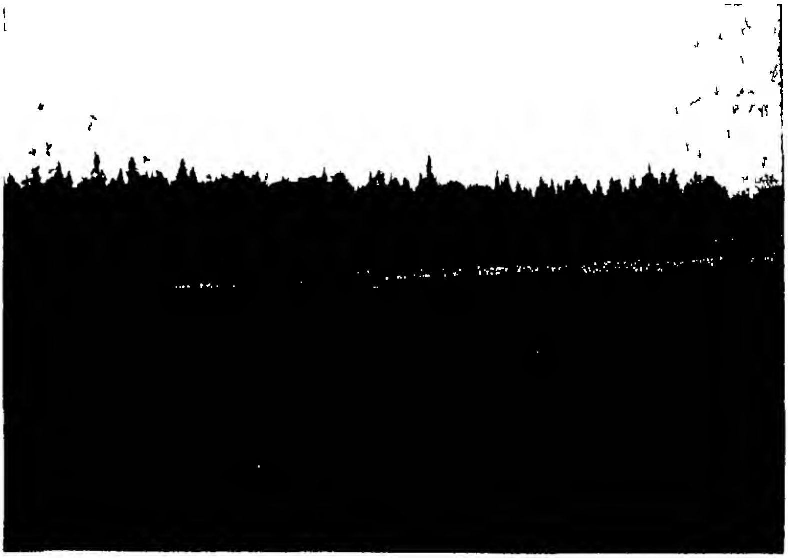


Fig 7 General View of the Southeastern Corner of Mud Lake, showing the False Bottom above Water.
The small plants carpeting the mud are *Eleocharis olivacea* August, 1921 Perry A Glick.

The number of plant species found in the lake is not large Growing submerged upon the false bottom the Chara-Potamogeton association is represented by *Potamogeton spp* and by *Myriophyllum spicatum*

The floating aquatics are represented by the Castalia-Nymphaea association These plants are found in isolated cases in the center of the lake and fairly well out in open water, but the most typical habitat for them is fairly close to the shore

where there are little bays In some of the very moist depressions on the mat, among the species of Sphagnum, both Castalia and Nymphaea were found Although *Nymphaea advena* is fairly well represented, *Castalia odorata* is much more abundant In the open water of the stream at the southeast side *Lemna minor* is very abundant

All around the lake there are clumps of *Carex filiformis* sometimes extending out in jagged patches into the water, but more often in pure stands forming close mats which cover large areas The roots of this plant mat together and the mats thus formed are hard to break through and provide a place where other plants can grow When the *Carex filiformis* mat has become fairly solid, other plants begin to invade, chiefly grasses and sedges

Following the *Carex filiformis* association, plants characteristic of the Iris-Aspidium association begin to appear Of these, *Aspidium thelypteris, Aspidium spinulosum, Campanula aparinoides, Drosera rotundifolia, Potentilla palustris* and *Lysimachia terrestris* were the ones most commonly found at Mud Lake

With the Chamaedaphne several additional ericaceous shrubs were associated The Chamaedaphne area was, for the most part, drier than either of the preceding areas, but no part of the bog was entirely dry during the summer of either 1922 or 1923 The bulk of the mat in this association was made up of a number of species of Sphagnum, including *Sphagnum capillaceum tenellum, Sphagnum fuscum, Sphagnum cuspidatum* and *Sphagnum dusenii* The most common herbs and shrubs in this association are *Andromeda glaucophylla, Drosera rotundifolia, Kalmia polifolia, Ledum groenlandicum, Menyanthes trifolia, Sarracenia purpurea, Scheuchzeria palustris, Vaccinium oxycoccos, Vaccinium pennsylvanicum nigrum* It is in this area that the orchids are present There were several species present at Mud Lake including *Habenaria hyperborea, Habenaria blephariglottis, Habenaria psychodes, Arethusa bulbosa, Calopogon pulchellus* and *Pogonia ophioglossoides*

A high bog shrub association succeeds the Chamaedaphne In it *Alnus incana, Nemopanthus mucronata* and *Ilex verticillata* are dominant Other shrubs present are *Rhamnus alnifolia*

Viburnum cassinoides, and seedlings of *Larix laricina, Picea mariana, Picea canadensis* and *Pyrus arbutifolia*

At many places about the lake both the *Carex filiformis* mat and the Iris association are missing and either Chamaedaphne or Alnus are at the water's edge A few feet behind it the high shrubs and trees appear

The bog is open and the plants growing in it are exposed to wind, light and heat There is practically no shade excepting that afforded by the few scattered trees and occasional shrubs There is always a supply of water available but, because of the stagnant conditions, oxidation and the removal of humic acids is slow The plants growing in the bog have many xerophytic adaptations, such as leathery leaves and special water-absorption structures, but they are merely xeromorphic rather than true xerophytes

In the lowland forest which succeeds the open peat bog the condition is quite different The floor of the forest is well shaded and very little direct sunlight enters There are many bare places in it Mosses are quite abundant especially species of Mnium, Thuidium and Hylocomium In some of the depressions where water is standing species of Sphagnum are found In other wet areas Drepanocladus is present In the higher places the ground plants were quite mesophytic The herbs most commonly found are *Coptis trifolia, Clintonia borealis, Cornus canadensis, Mitchella repens Galium spp , Linnaea borealis americana* and *Pyrola sp*

The trees are quite large and close together In areas which have not been disturbed *Picea mariana, Picea canadensis* and *Thuja occidentalis* are practically the only trees in the forest *Larix laricina* is found at the edge of the forest The forest at the south, southwest and north edges of the bog are of this type, but examples of it may be found at almost any point about the lake

In the lowland at the northeast part of the bog where fires have burned the trees, there is an area with considerable standing water with a thicket of young trees Here the aspens and the peat bog birch, *Betula glandulosa*, are present in great numbers

Most of the forest surrounding Mud Lake is, however, of the first type

There are a number of plants in the bog that are not common in the region and should be given special mention At the west end of the lake *Scirpus hudsonianus* is present Other plants which are rare in the region are *Scheuchzeria palustris, Carex limosa, Pogonia ophioglossoides, Drosera longifolia* and several of the mosses, *Sphagnum papillosum, Meesia triquetra, Drepanocladus vernicosus* and *Dicranum bergerii*

The peat borings, which were taken in certain definite lines beginning at the margin of the lake and extending toward the outer edge of the bog, are indicated on the map The area about the Stations 9 and 10 was the shallowest, while that at Station 1 was the deepest Rather firm uniform peat was found at an average depth of seven feet at the margin of the lake Beneath the peat, blue clay was present and beneath that, sand In the blue clay shells were found

SUMMARY

The vegetation on the mat of Mud Lake is that characteristic of bogs, *Carex filiformis, Chamaedaphne calyculata, Nemopanthus mucronata* and *Alnus incana* are among the most common forms

Several species of Sphagnum are present

The forest which surrounds the bog is of the lowland Thuja-Picea-Larix type

Fires have burned through a number of times so that retrogression has taken place and the natural successions have been more or less disturbed and the associations intermingled

There is very little living vegetation in the lake A false bottom occurs a short distance below its surface Below the false bottom peat in various stages is found Below the peat, blue clay is present, and below it, sand

The greatest depth of the lake is twenty-two feet at Station 1 The shallowest portion of the lake was nine feet in depth

Eventually the entire Mud Lake bog may become a bog forest, but at the present time it is in a comparatively young stage with open water, mat and bog forest all present

PEAT READINGS

STATION 1
- 9 ft, gelatinous peat
- 11 ft, gelatinous peat with clay and shells
- 13 ft, clay and peat
- 15 ft clay with some plant fibers
- 17 ft, pure blue clay
- 19 ft, pure blue clay
- 21 ft, clay and sand mixed
- 22 ft, pure sand

STATION 2
- 9 ft, gelatinous peat
- 10 ft, gelatinous peat with clay
- 11 ft, soft blue clay
- 13 ft, blue clay
- 13 ft +, sand, pure

STATION 3
- 9 ft, gelatinous peat
- 10 ft, gelatinous peat with clay
- 11 ft, blue clay, many shells
- 12 ft, pure sand

STATION 4
- 8 ft, gelatinous peat
- 9 ft, peat and blue clay
- 9 ft, 6 in, pure sand

STATION 5
- 8 ft, peat with plant remains
- 9 ft, blue clay and sand
- 9 ft 6 in, pure sand

STATION 6
- 8 ft, peat and plant remains
- 9 ft, clay and sand
- 10 ft, pure sand

STATION 7
- 9 ft, pure peat
- 10 ft, clay and sand
- 11 ft, sand and gravel

STATION 8
- 5 ft, liquid
- 8 ft, gelatinous peat, remains of plants
- 10 ft, peat with plant remains and shells
- 11 ft, clay with snail shells
- 12 ft pure blue clay

STATION 9
- 7 ft, peat with plant remains
- 9 ft, blue clay
- 11 ft, coarse gravel

STATION 10
- 7 ft, soft peat
- 9 ft, blue clay
- 9 ft 6 in, very hard clay
- 10 ft, sand

STATION 11
- 7 ft, peat
- 8 ft peat, clay and sand mixed
- 8 ft 6 in, pure sand

STATION 12
- 7 ft, gelatinous peat
- 7 ft 6 in, gelatinous peat becoming solid
- 8 ft, sand and peat mixed

STATION 13
- 5 ft, very liquid
- 6 ft, pure peat
- 10 ft, blue clay
- 11 ft, pure sand

Between STATIONS 2 AND 4

Readings taken on the mat

1 On shore at Station 2
- 2 ft, mostly water, some undecayed plant remains
- 4 ft, watery peat
- 6 ft, impure peat, few snail shells
- 8 ft, fine peat
- 10 ft, clay and shells
- 13 ft, pure sand

2 10 ft from shore
- 13 ft, sand and clay, mostly sticky clay

3 50 ft from margin
- 2 ft, undecayed plant remains Very liquid
- 4 ft, gelatinous peat

8 ft, peat with some plant remains
10 ft, blue clay
12 ft, sand and clay mixed
4 100 ft from margin
2 ft, plant remains undecayed
4 ft, plant remains partially decayed
6 ft, peat with plant remains
8 ft, pure homogenous peat
10 ft, blue clay
12 ft, sand

STATION 7 — *From margin of lake through aspen association*
1 At margin
2 ft, gas, very soft peat with partially decayed plant remains
4 ft, very soft gelatinous peat
6 ft, mostly peat some blue clay and very little sand
7 ft, very coarse gravel
2 20 ft from margin
2 ft, liquid
4 ft, fairly uniform peat, few plant fiber remains
5 ft, sand
3 45 ft from margin
4 ft, sand
4 60 ft from margin
3 ft, soft peat
4 ft, peat, blue clay and sand
5 75 ft from margin
4 ft, sand
6 135 ft from margin
2 ft, little peat, blue clay and sand
7 150 ft from margin
2 ft, gelatinous peat with decayed vegetation No farther
8 180 ft from margin
1 ft 3 in, blue clay and sand
9 183 ft from margin
1 ft 3 in, blue clay and sand
10 210 ft from margin
1 ft, sand

STATION 5 — *Trail from margin through aspen association*
1 At margin
2 ft, liquid
4 ft, very soft peat
6 ft, firm peat
8 ft, peat and blue clay
8 ft 3 in, sand
2 50 ft from margin
4 ft, peat with partially decayed plant remains
6 ft, pure peat
7 ft, blue clay
7 ft 6 in, pure sand
3 75 ft from margin
7 ft, sand and coarse gravel
4 90 ft from margin
5 ft, blue clay
5 ft 2 in, sand
5 100 ft from margin
2 ft very soft peat with plant remains
3 ft, peat
4 ft, peat and blue clay
4 ft 3 in, sand
6 115 ft from margin
4 ft, peat, blue clay, and sand
7 130 ft from margin
2 ft 6 in, very soft peat with undecayed plant remains
3 ft, coarse sand
8 155 ft from margin
1 ft 6 in, very soft peat
1 ft 9 in, coarse sand
9 180 ft Aspen association starts
1 ft, very soft peat and sand
10 205 ft from margin
6 in, peat and sand

STATION 3 — *From margin through Chamaedaphne association*
1 At margin
2 ft, liquid brownish peat
4 ft, gelatinous peat, rather black
6 ft, same as 4 ft record
8 ft, same as 4 ft record
10 ft, peat and blue clay, shells present

10 ft 1 in, blue clay and sand, very hard
2 100 ft from margin
2 ft, liquid
4 ft, extremely gelatinous peat, much decaying vegetation
6 ft, fairly uniform gelatinous peat
8 ft, much the same as at 4 and 6
9 ft 6 in, soft brownish peat
10 ft, sand
3 200 ft from margin
2 ft, gas
4 ft gas
6 ft rather solid peat, tangled mass of plant remains
8 ft rather firm peat, great many shells and plant fibers
10 ft, fairly firm peat, some plant fibers
10 ft 6 in, blue clay
10 ft 9 in, whitish clay mixed with coarse sand
4 300 ft from margin
2 ft, liquid
4 ft, liquid
6 ft, liquid
8 ft, gelatinous peat, few shells
10 ft, peat and blue clay, plant fibers
11 ft, sand
5 400 ft from margin
2 ft, liquid
4 ft, liquid, gas
6 ft, soft peat with undecayed plant remains
8 ft, rather firm peat, partially decayed plant remains
10 ft, peat, slight mixture blue clay, plant remains
11 ft, sand
6 500 ft from margin
2 ft, liquid
4 ft, liquid, gas
6 ft, partially decayed plant fibers
8 ft, firm peat with few plant fibers
10 ft, mostly peat little blue clay, and partially decayed plant fibers
11 ft, mixture of blue clay and sand
12 ft sand
7 600 ft from margin
2 ft, liquid
4 ft, liquid
6 ft, partially decayed plant fibers, soft peat
8 ft firm peat partially decayed plant fibers
10 ft, sand

STATION 4 - *At inlet, 50 ft from margin*
1 In water of inlet
7 ft, liquid peat with plant

8 ft,

STATION 13
1 At margin of lake
2 ft gas liquid
4 ft, gas, liquid peat
6 ft, homogenous peat
7 ft 6 in, coarse sand
2 25 ft from margin
4 ft, gas, soft peat
6 ft, peat, some plant remains
8 ft, sand
3 50 ft from margin
4 ft, soft brown peat with plant remains
6 ft, homogenous peat
7 ft, sand
4 75 ft from margin
4 ft, soft peat
6 ft, homogenous peat
6 ft 6 in, sand
5 100 ft from margin
6 ft, peat
6 ft 2 in, sand

List of Plants Found Growing in the Mud Lake Bog

Abies balsamea
Acer pennsylvanicum
Acer rubrum
Acer saccharum
Acer spicatum
Agrimonia gryposepala
Alnus incana
Andromeda glaucophylla
Apocynum androsaemifolium
Aralia nudicaulis
Aralia racemosa
Arceuthobium pusillum
Arethusa bulbosa
Asclepias syriaca
Aspidium spinulosum
Aspidium thelypteris
Aster junceus
Aster novae-angliae
Aster spp
Betula alba papyrifera
Betula glandulosa
Betula lutea
Bidens comosa
Boehmeria cylindrica
Botrychium virginianum
Calla palustris
Calopogon pulchellus
Caltha palustris
Campanula aparinoides
Cardamine pratensis
Carex bebbii
Carex comosa
Carex crinita
Carex diandra
Carex filiformis (= C lasiocarpa)
Carex hystericina
Carex intumescens
Carex leptalea
Carex leptonervia
Carex limosa
Carex oligosperma
Carex paupercula
Carex pauciflora
Carex scirpoides
Carex stricta
Carex substricta
Carex tenella
Carex trisperma
Carex spp
Castalia odorata
Chamaedaphne calyculata
Cicuta bulbifera
Circaea alpina
Clintonia borealis
Coptis trifolia
Corallorrhiza odontorhiza
Cornus canadensis
Cypripedium hirsutum
Diervilla lonicera
Drosera longifolia
Drosera rotundifolia
Eleocharis acuminata
Eleocharis olivacea
Epilobium angustifolium
Epilobium molle
Epipactis decipiens
Eriophorum callithrix
Eriophorum virginicum
Eriophorum viridi carinatum
Eupatorium purpureum
Fagus grandifolia
Fragaria virginiana
Galium labradoricum
Galium tinctorium
Galium trifidum
Geum strictum
Glyceria nervata
Habenaria blephariglottis
Habenaria hyperborea
Habenaria leucophaea
Habenaria psycodes
Ilex verticillata
Iris versicolor
Kalmia polifolia
Larix laricina
Ledum groenlandicum
Lemna minor
Linnaea borealis americana
Liparis liliifolia
Lonicera oblongifolia
Lycopus americanus
Lycopodium clavatum
Lysimachia terrestris
Maianthemum canadensis

List of Plants Found Growing in the Mud Lake Bog

Melampyrum lineare
Menyanthes trifolia
Mitchella repens
Mitella nuda
Mosses
  Drepanocladus vernicosus
  Dicranum bergeri
  Hylocomium sp
  Mnium sp
  Meesia triquetra
  Polytrichum juniperinum
  Sphagnum capillaceum tenellum
  Sphagnum cuspidatum
  Sphagnum dusenii
  Sphagnum girgensohnii
  Sphagnum megellanicum
  Sphagnum palustre
  Sphagnum papillosum
  Sphagnum wulfianum
  Thuidium sp
Muhlenbergia racemosa
Myriophyllum spicatum
Nemopanthus mucronata
Nymphaea advena
Oenothera biennis
Onoclea sensibilis
Onoclea struthiopteris
Osmunda cinnamomea
Osmunda regalis
Ostrya virginiana
Phegopteris dryopteris
Picea canadensis
Picea mariana and its bog modification
Pilea pumila
Poa compressa
Poa pratensis
Pogonia ophioglossoides
Populus grandidentata
Populus tremuloides
Potentilla palustris
Potamogeton spp
Prunus pennsylvanica
Pteris aquilina
Pyrus americana
Pyrus arbutifolia
Rhamnus alnifolia
Ribes glandulosum
Ribes triste albinervium
Rubus triflorus
Rynchospora alba
Sarracenia purpurea
Scheuchzeria palustris
Scirpus hudsonianus
Solidago rugosa
Solidago uliginosa
Spiranthes cernua
Spiranthes romanzoffiana
Taxus canadensis
Thuja occidentalis
Trientalis americana
Triglochin maritima
Tsuga canadensis
Typha latifolia
Ulmus americana
Utricularia intermedia
Vaccinium canadense
Vaccinium macrocarpon
Vaccinium pennsylvanicum nigrum
Vaccinium oxycoccos
Viburnum cassinoides
Viola pallens
Viola spp

TABLE OF TYPICAL HYDROGEN ION READINGS TAKEN BY DR MINNA JEWELL IN 1922

DATE		LOCATION	pH
July	31	Station 7, connected with lake	6 7
	31	15 ft inland	7 0
	31	50 ft inland, under Thuja	7 1
Aug	3	Between Stations 6 and 7, 25 ft from lake, border of Thuja and mat	6 8
	9	Station 13, in lake	7 4
	9	8 ft from lake, Sphagnum mat	3 6
	9	100 ft from lake, Sphagnum mat with several dead conifers	3 4
	9	Lagoon from lake between Stations 13 and 1 Mouth narrow, hence little interchange of water with lake	5 6
	9	75 ft back from lagoon	3 3
	9	25 ft inland from Station 1, small Spruce	3 35
	9	Carex-Sphagnum mat between Stations 1 and 2	3 25
	9	Inlet near trail	6 2
	9	Lagoon from inlet near edge of woods	5 7
	10	Upper waters of inlet among Thuja	6 5 to 6 6
	10	Lake near outlet	7 2
	10	Outlet, 8 ft from lake	7 8 to 8 0
	10	Outlet, 15 ft from lake in Carex	8 0
	10	Sphagnum mat between Station 13 and 1	3 6
	10	Same location, among water lilies (6 readings)	3 4 to 3 7
	11	Carex-Aspidium mat near Station 5 10 ft from lake	6 2
	11	Same, 15 ft from lake	6 9
	11	Same, farther back between small Larix, Alnus and first Thuja	6 8
	11	Same, under first Thuja	6 6
	11	Same, among Typha 6 ft from lake	5 8
	11	Same, among Typha 10 ft from lake	6 2
	11	Same, beyond Typha some 12 ft from lake	6 2

UNIVERSITY OF MICHIGAN BIOLOGICAL STATION
CHEBOYGAN, MICHIGAN

THE GENUS LEPIOTA IN THE UNITED STATES *

C H KAUFFMAN

A CAREFUL business man takes an inventory of stock on hand at certain intervals in the development of his business It would appear that this common-sense procedure could be applied equally to systematic mycology, and that if the knowledge on hand were put together in compact form, and the species no longer known or names no longer tenable could be thrown on the rubbish heap, a large amount of confusion and error in our accounts of existing plants would be eliminated It is with the hope of bringing about some such result that the present paper has been prepared Various sections of the United States have been visited during the last ten years, and although comparatively few new species were discovered and not nearly all of the supposedly native or described species were collected, yet a sufficient number of studies have been made to make a review of the genus possible

The genus Lepiota comprises many species, and the monographic accounts that have appeared from time to time indicate that the genus has special attractions for the mycologist Dr Peck, in the *35th Report of the New York State Museum*, as long ago as 1884, gave a detailed account of eighteen species then known to him from that state C G Lloyd in one of his first numbers of *Mycological Notes*, published in 1898, gives an account of seven of the larger species Since Mr Lloyd knows how to photograph fungi, it is to be regretted that he did not follow up his first output of agaric pictures Then came A P Morgan's monograph of the genus, appearing in Volumes 12 and

* Paper from the Department of Botany of the University of Michigan, No 216

13 of the *Journal of Mycology*, 1906–1907 I doubt whether mycologists have studied Mr Morgan's arrangement of species as carefully as it deserves We have here an effort to lay a firm foundation for the American species within this genus, and Mr Morgan, by careful choosing of terms, tried to bring all related species together under headings which would indicate their morphological development Finally, a comprehensive account of all the known North American species appeared in 1914, in the *North American Flora*, Vol 10, Part I Here Dr Murrill recognises ninety-seven species, of which nine are segregated and placed in the genus Limacella, proposed in 1909 by F S Earle

Since Peck's first list, the number of species recognized in the United States has increased fivefold Peck himself described a large number, and Professor Atkinson added some from time to time, Morgan himself named fifteen of those enumerated in his monograph, while Dr Murrill added a goodly number, especially from the poorly explored regions of the West and South

Many of the ninety odd species now on record for the United States are too incompletely known and described The difficulty which Morgan encountered in properly placing species can be easily read between his lines Those which he himself collected and studied, he had no difficulty in placing under the appropriate section to which, by their structure and development, they naturally belonged, but when he was compelled to place a species described by someone else, he frequently had to guess at the possible structure of such plants, and sometimes he vacillated as regards the section into which the plant should be placed The present writer has experienced these same difficulties, and some of the points involved will be discussed under "Comments" later in the paper

The name Lepiota was used for the first time by Persoon He applied it to those white-spored Agarics with an annulus on the stem and with innate scales on the pileus Lange (9) in transferring *Armillaria mellea* to the genus Lepiota seems to have gone back to Persoon's broad characterization of the group Lange, however, uses other arguments to support his attitude

Fries (4) limited the group, as a tribe under Agaricus, much as we have it at present Quélet (11) raised it to generic rank The important European works dealing with the genus Lepiota since the time of Fries and Quélet are those by Quélet and Battaille (12), Ricken (14), Lange (9) and Rea (13) Further discussion of the views of European authors will be limited to the sections below under "Comments"

The genus Lepiota is here kept intact except for the removal of those species of the old group "granulosae," which have adnate or adnexed gills, and which are therefore more properly Armillarias (8) A list of these is given below The genus has been divided into sections by various authors in different ways That these sections do not remain static in their content, merely shows once more the need of more accurate and complete knowledge of the species already described, and more care in describing new ones In this paper the species are grouped in seven sections Lubricae, Viscidae, Pruinosae, Subclypeolariae, Clypeolariae, Asperae, Procerae-annulosae

If the morphological development from the initial button stage were already worked out for most of the species, then the grouping within these sections could be made permanent Only a few species, however, have been studied from this point of view Atkinson (1, 3) published an account of *Lepiota clypeolaria, Lepiota cristata* and *Lepiota seminuda* From his studies on these and other species of agarics which possess partial veils or universal veils, he was able to point out the essential nature of these veils (2) In these papers he shows that a differentiated universal veil can be detected around the young buttons of certain species This enveloping zone Atkinson calls the *blematogen* and it may take one of two possible courses during the further development of the button or fruit-body, in the one case, the developing veil becomes intergrown with the primary tissue of the pileus, and is therefore at length concrete with it, as in *Lepiota clypeolaria,* in the other case, there is a gelatinizing of an inner layer of hyphae of this outer enveloping zone of tissue in such a way that it causes a loosening of the outer portion to form the volva, the latter then separates at maturity as in Amanita

or Amanitopsis This differentiated tissue, which forms a true volva, Atkinson called the *teleoblema* The genus Lepiota is, then, definitely and generically distinct from Amanita and Amanitopsis, without reference to the other differences in development The variations in the character of the cap-covering, in different species of Lepiota, is doubtless due to the amount and texture of the tissue derived originally from the blematogen

If we turn now to the stem characters, we find that the facts concerning the development of the annulus and stem-covering are not as clearly worked out as those of the pileus In separating the genus into sections, the characters of the annulus and stem-covering play a rather important part These characters also are generally poorly studied or recorded by those who describe new species, and it is here that difficulties arise when monographic arrangements of the species are attempted Atkinson has given us a clear picture of the layers of tissue of the stem-covering in *Lepiota clypeolaria* Here the rather dense tissue in the gill cavity — later to become the partial veil and annulus — extends downward thinly to the base of the stem Enveloping this thin layer is the tissue of the universal veil, which is concrete with the inner layer and which breaks up into cottony scales It may be said, in passing, that these parts can be made out in the field with a good hand lens, and it is essential that all species collected and described should be studied in this way when collected *L clypeolaria* is an example of the kind of species which should go into the section Clypeolariae as given below

Atkinson gave some attention to the details of development of annulus and stem-covering in *Lepiota cristata* The blematogen on the stem is composed of hyphae parallel to the stem and is poorly developed, i e , there is so little of it that the thin, almost unnoticeable, peronate sheath which terminates in the annulus when the plant is partly grown or expanded, cannot be accounted for by this layer Atkinson pointed out, however, that the thin, descending tissue connected with the tissue of the gill cavity later becomes much thicker In the section Subclypeolariae, given below, there is probably this type of development through-

out the section, at least it may be assumed that only this type of species should be included in this section As constituted in the present paper, it will be seen that the presence of a definite annulus of the truly membranous type is the fundamental basis of the section referred to

The species which come under the section Pruinosae, as limited in this paper, should have a pulverulent, flocculose or obsolete covering on the surface of the pileus and on the stem, and this covering is assumed to be derived from the blematogen In addition, the annulus is not truly membranous, or at least it is delicate and poorly developed Here again, one can not at present be consistent, because of the incomplete data for quite a number of species Atkinson studied the development of *Lepiota seminuda*, as a representative of this group He found the mealiness due to the breaking down of the blematogen tissue, its hyphal cells separating into turgid cells Of course, not all the species included below in this section have this type of cap- and stem-covering, and doubtless a number of groupings can be made when more developmental studies give us the details There is, however, a reasonable limit to the subdividing that may be done, and relations will have to be worked out with some degree of conservatism

No studies of any consequence have yet been made of the development from the early stages, for the species belonging to our other sections In the Lubricae, with a gelatinizing and therefore viscid or glutinous outer layer on both pileus and stem, it seems clear that a universal veil of the blematogen type is present There is reason to suspect that such a layer is well developed in the sections Asperae and most of the Procerae-annulosae The last group has usually been placed under two sections, but the structures, during development, in spite of the size of the plants, have not been sufficiently studied in many cases, so that no acceptable line of separation seems possible at present

Many of the species of Lepiota are quite peculiar in their fruiting habits There are, in a broad sense, two types with reference to habitat, those which appear on cultivated land,

among grass or in ploughed fields, or on similar ground, and those which grow in forests, thickets or other shady and moist places Many, if not most of them, fruit under much drier conditions than other agarics When collecting is good for many genera, i e, during continuous wet weather, the fruit-bodies of Lepiota are apt to be rare or scattered, after the wet weather ceases, and other forms no longer appear, then it is frequently possible to find Lepiotas, often an unusual number of the smaller species

In the following synopsis of species it has seemed best to eliminate in the beginning those species reported from the tropics or scarcely extending into our southern states, as well as those which have apparently been introduced from the tropics and appear sporadically in hothouses or conservatories These two sets of species will be merely listed, except for brief comments on a few of them given elsewhere

List of Lepiotas Recently Described from the Tropics or Subtropics

Lepiota abruptibulba Murrill, Cuba
agricola Murrill (as Limacella), Jamaica
aspratella Murrill, Jamaica
Broadwayi Murrill, West Indies, Granada
candida Copeland (non Morgan), Philippines
chlorospora Copeland, Philippines
colimensis Murrill, Mexico
dryophila Murrill, Louisiana (New Orleans)
elata Copeland, Philippines
ferruginea Bres, Africa
flavodisca Murrill, Cuba
hemisclara (B & C) Sacc, Cuba
jamaicensis Murrill, Cuba
lactea Murrill, Cuba
longistriata Pk, Cuba, Jamaica, Alabama
manilensis Copeland, Philippines
mississippiensis Murrill, Mississippi
rimosa Murrill, Cuba
subclypeolaria (B & C) Sacc, Cuba
subgrisea Murrill, Jamaica
subcristata Murrill, Jamaica
subflavescens Murrill, Louisiana
subgranulosa Murrill, Mexico
subrivelata Murrill, Louisiana

subphopenita Graff, Philippines
tepeitensis Murrill, Mexico
testacea Murrill, Mexico
xylophilus Pk, Hawaii

List of Lepiotas Occurring in Hothouses, etc, Apparently Introduced from the Tropics

Lepiota Allenae Pk (Massachusetts, greenhouses)
amantiformis Murrill (New York City, conservatories)
avellanea Clements (Nebraska, greenhouses)
biornata B & Br (England, melon and cucumber frames)
cepaestipes Fr (Europe and North America, also native)
denudata Fr (Europe, in tanneries, flowerbeds, also native?)
farinosa Pk (*Massachusetts, mushroom bed in hothouse*)
Georginae W J Smith (England, fern houses)
licmophora B & Br (England, greenhouses)
lilacina-granulosa P Hennings (Europe, greenhouses)
lutea (Bolt) Quél (Syn *L citrina* Pass per Bres) (Europe, hot houses)
magnusiana P Hennings (Germany, hothouses)
martialis Cke & Massee (England, on trunk of tree fern, greenhouse)
medioflava Boudier-Rea (Europe, hothouses)
meleagris Fr (Europe and America, hothouses, etc, also native)
micropholis B & Br — Lange (Europe, hothouses)
pseudolicmophora Rea (England, greenhouses)
spectabilis Clements (Nebraska, greenhouse)

List of Species of Lepiota Transferred to the Genus Armillaria

Lepiota constricta (Fr) Quél = Rea = Armillaria constricta Fr
adnatifolia Pk = Armillaria adnatifolia (Pk) Kauff (8)
amianthina Fr = *Armillaria* amianthina (Fr) Kauff (8)
carcharia Fr = Armillaria carcharia (Fr), comb nov
cinnabarina Fr = Armillaria cinnabarina (Fr) Kauff (8)
granosa Morg = Armillaria granosa (Morg) Kauff (8)
granulosa S E Gray = Fr = Armillaria granulosa (Fr) Kauff (8)
pulveracea Pk = Armillaria pulveracea (Pk), comb nov
rhombospora Atk = Armillaria rhombospora (Atk), comb nov
haematites Berk = Bres = Armillaria haematites (Bres), comb nov

Synopsis of the Species of Lepiota of the North Temperate Regions of Europe and America

(Compiled in part from the literature)*

Young plant enclosed in a glutinous universal veil — I LUBRICAE

Surface of pileus viscid, because of a gelatinizing, more or less separable pellicle, stem dry — II VISCIDAE

Pileus and stem covered when in good growing condition, by mealy, floccu-lose or granular particles, sometimes subscaly, veil and annulus delicate, of the same texture or substance as the covering on the pileus, hence the annulus is evanescent — III PRUINOSAE

Annulus membranous, thin but distinct, often persistent, frequently terminating a thin, smooth, peronate (i e external) layer of the stem, or stem entirely naked, cuticle of the pileus at first continuous, then diffracted-scaly except on disk — IV SUBCLYPEOLARIAE

Universal veil well developed, but concrete, breaking up into colored fibrillose or floccose-fibrillose scales or masses on the pileus and stem, on the latter, terminating the sheath in the form of a floccose or fibrillose, soon evanescent annulus — V CLYPEOLARIAE

Universal veil composed of a thick loose fibrillose layer covering the pileus and stem from the first, when drawn apart by the expansion of the pileus or by the elongation of the stem, its fibers converge into conspicuous erect, or squarrose scales, the partial veil tends to be fine-fibrillose or subarachnoid, often copious — VI ASPERAE

Plants mostly rather large, annulus well developed, membranous, sometimes thick and appearing double, sometimes mobile on the stem Pileus diffracted-scaly, sometimes fibrillose, rarely glabrous — VII PROCERAE-ANNULOSAE

I LUBRIÇAE

1 Taste of pellicle not bitter — 2

1 Taste of pellicle very bitter, plant white (See description) (*L candida* Morgan) *L pulcherrima Graff*

2 Spores ovoid-ellipsoid — 3

2 Spores globose or subglobose — 5

3 Pileus 5–8 cm broad — 4

3 Pileus 2–5 cm broad, white with fulvous umbo, gills narrow, stem long, slender, hollow, abruptly bulbous, spores 7 5–10 × 4–5 μ, annulus membranous, in woods — *L fulvodisca* Pk

---

* The microscopic characters, e g size and shape of spores, have been reported for the older species by various students of Agarics In order to show whose account of these characters is followed in the ensuing synopsis, the names of such authors are added, where necessary, after the older author's name

4 Spores 9–11 × 5–6 μ, pileus whitish to pale alutaceous, gills narrow, stem rather stout, stuffed, subbulbous *L bentista* Morgan
4 Spores 5–6 × 3–4 μ, pileus alutaceous to subfulvous, with darker umbo, stem equal or subequal, hollow or stuffed, floccose below *L oblita* Pk
5 Viscid layer of pileus and stem hyaline 6
5 Viscid layer thick, brown, pileus 3–4 cm obtuse, stem 4–6 cm × 3–4 mm, solid, tapering upward, gills broad, spores 4–5 μ diameter *L glischra* Morgan
6 Pileus cream-color, tinged rosy, 6 cm broad, with broad umbo, stem 5–10 cm × 8–12 mm, solid, enlarged at base, odor farinaceous, spores unknown *L roseicrema* Murrill
6 Pileus white, 4–7 cm broad, glutinous, gills soft, subvenose-connected, stem 5–8 cm × 4–6 mm, equal, soon hollow, glabrous, spores 4–6 μ diameter *L illinita* Fr

II VISCIDAE

1 Pileus rather large, 5 10 (14) cm broad, annulus ample, membranous, pendant (Transition to *Amanita*) 2
1 Pileus smaller, annulus usually narrow, median or superior 4
2 Taste distinctly farinaceous, apex of stem dotted with dark green drops when developing, pileus 7–10 cm broad, pinkish-tan, stem spongy-soft, more or less scaly, spores globose, 5–6 μ (Ricken) (*L guttata* (Pers) Quél) (*Amanita lenticularis* Fr) *L lenticularis* Lasch-Ricken
2 Taste not farinaceous, apex of stem without green watery drops 3
3 Pileus 8 14 cm broad, whitish with brownish disk, thick and firm, glabrous, gills white, stem equal, 8–15 cm × 15–25 mm, solid, odor none, spores unknown *L Persoonii* Fr -Ricken
3 Pileus 4–9 cm broad, white to pale alutaceous, rather soft, glabrous, gills crowded, white, edge entire, stem 4–10 cm × 4–10 mm, subbulbous, odor becoming strong and disagreeable, spores oval 3–4 × 2–3 μ *L Fischeri* Kauff
4 Odor of radish, pileus, etc , white, 3–6 cm, umbonate, flesh soft, watery, stem hollow, annulus lacerate, usually appendiculate on edge of pileus, spores unknown *L medullata* Fr
4 Odor not of radish 5
5 Spores globose or subglobose 6
5 Spores elliptical, stem stuffed or hollow 8
6 Taste not farinaceous, pileus yellowish, 2 5–5 cm, covered like the stem with dew-like transparent drops, stem white above, with yellow or brownish squamules below, spores 4–5 μ diam, in pastures *L irrorata* Quél -Rea
6 Taste farinaceous, pileus 2–5 cm, convex, glabrous, even, gills ventricose, close, white, stem 4–7 cm × 4–10 mm, solid, spores globose, 4–5 μ 7
7 Pileus "burnt sienna" to "mars-orange" (Ridg), fading, stem with reddish, floccose scales up to the slight annulus *L glioderma* Fr

7 Pileus pinkish-cream color, stem subglabrous, annulus ample, superior, persistent *L McMurphyi* Murrill

8 Pileus, etc, white, 1–3 5 cm subumbonate, glabrous, even, gills crowded, narrow, stem slender 5–8 cm × 3 5 mm, annulus apical, membranous, at first erect, spores short-ellipsoid 5 7 5 × 3–3 5 μ (*L candida* Morg) (*L albissima* Murrill) *L pulcherrima* Graff

8 Pileus not white 9

9 Pileus delicately pink, 2–4 cm subviscid, even, gills narrow, flesh white, unchanged, stem 5 9 cm × 3–5 mm, glabrous, soft, stuffed, annulus median, spores subacute at ends, ellipsoid, 5–6 × 3–4 μ (*L delicata* var Kauff, *Agar Mich*, I 631) *L rubida*, sp nov

9 Pileus ochraceous-fulvous, 4–5 cm, radiate-wrinkled, gills broad, flesh whitish, blackening at base of stem, stem equal, 8 cm × 5–7 mm, annulus oblique, black-scaly, blackish fibrils appendiculate on margin of pileus, spores 5–6 × 3–4 μ *L demisannula* Secr -Ricken

III PRUINOSAE

1 Spores averaging 9 μ or more in length 2

1 Spores averaging less than 8 μ, often minute 9

2 Spores subfusiform, 12 μ or more in length 3

2 Spores elliptical, oblong or oval 5

3 Pileus 1 5–2 5 (3) cm broad 4

3 Pileus 6–12 mm broad, with minute whitish or cinereous, granular scales, substriate, gills broad, distant, stem 1 5–2 5 cm long, slender, glabrous, whitish, spores 12–15 × 5–6 μ *L arenicola* Pk

4 Gills white, becoming fumose on drying, broad, pileus 2–3 cm, with isabelline, powdery scales, stem 5–6 cm × 4–6 mm, furfuraceous, pale drab below, spores 12 × 7 μ *L fumosifolia* Murrill

4 Gills white with gilvous tint, pileus 1 5–2 5 cm, gilvous or fulvous-ochraceous on disk, margin pale, stem about 3 cm × 3 mm, with floccose scales, spores 11 5–13 5 × 4 5 μ (*L gracilis* Quél var *laevigata* Lange) *L laevigata* Lange, comb nov

5 Pileus not over 3 5 cm broad 6

5 Pileus rather large, 4–8 (10) cm, striate-plicate on margin, densely flocculose-scaly, yellowish-brown, brown on disk, stem subventricose or tapering upward, 4–12 (15) cm × 4–6 mm at apex, up to 15 mm at thickest part, subglabrous, annulus subpersistent, spores 9–10 × 5–7 μ, oval-elliptical *L cepaestipes* Fr

6 Pileus with lilac or purple color present 7

6 Pileus white, disk changing to brown on drying, 2–3 5 cm, disk subscabrous, stem 2–3 cm × 2–4 mm, spores 8–10 × 5–6 μ *L mutata* Pk

7 Pileus or flocculose scales lavender or lilac-tinged 8

7 Pileus and stem covered with a heliotrope-purple pulverulence, 1–2 cm, flesh white tinged-yellow, gills broad, rather distant, spores 8–10 × 3–4 μ *L purpureoconia* Atk

8 Odor fetid, gills rather narrow, pileus 1–2 cm minutely scaly, stem toughish, dark brown to blackish below, 4–5 cm × 2–2 5 mm, spores 9–11 × 2–2 5 μ *L ecitodora* Atk

8 Odor none, gills broad, subdistant, pileus 1.5–2.5 cm., floccose-scaly, brownish tinged with lilac, stem concolor below, 1.5–2.5 cm. $\times$ 2–4 mm., spores $10 \times 5\ \mu$ — *L. sublilacea* Pk.

9 Spores minute, scarcely reaching $5\ \mu$ in length — 10

9 Spores $6\ \mu$ or more in length — 16

10 Stem rufous-tinted, rufescent or rosy-tinted beneath the superficial fibrils or pulverulence — 11

10 Stem whitish, 2–3 cm. long, 1 mm. thick, glabrous, pileus oval to convex, obtuse, pink-tinged when young, granular-mealy, gills subdistant, spores $4\text{–}5 \times 3\ \mu$ — *L. cristatatella* Pk.

11 Pileus 2–3.5 cm. broad — 12

11 Pileus averaging less than 2 cm. — 13

12 Pileus white, disk rufescent, very minutely flocculose, gills rather broad, stem 4–6 cm. $\times$ 2–3 mm., spores ovoid-oblong, $3.5\text{–}4.5 \times 3\ \mu$ — *L. roseilata* Britz.-Morgan

12 Pileus bright rose color, densely granular, convex, gills at length ochraceous, flesh rufescent, stem 5–6 cm. $\times$ 3–5 mm., spores $5 \times 3\ \mu$, elliptical — *L. rosea* Rea

13 Pileus and stem covered with mealy, white particles — 14

13 Pileus and stem glabrous, pileus 8–10 mm., white, stem 2–3 cm. $\times$ 1–2 mm., rufescent, gills broad, spores oblong, $4\text{–}5 \times 2\text{–}3\ \mu$ — *L. rufipes* Morgan

14 Pileus umbonate, 8–20 mm. broad, gills broad — 15

14 Pileus convex, obtuse, white or nearly so, 4–8 mm. broad, gills broad, spores elliptic-oblong, $4\text{–}5 \times 2.5\text{–}3\ \mu$ — *L. pusillomyces* Pk.

15 Pileus milk-white, spores $4 \times 2\ \mu$ — *L. hemisphaerica* Murrill

15 Pileus whitish, tinged flesh-color, spores $4 \times 2\ \mu$ (Rea), $4 \times 2.5\ \mu$ (Lange), $5\ \mu$ long (Quél.) — *L. seminuda* (Lasch) Quél.

16 Spores subglobose — 17

16 Spores ellipsoid, pileus between 1.5 cm. and 3 cm. broad — 18

17 Pileus incarnate-ochraceous, umbonate, with minute granular scales, stem granular, 2–3 cm. $\times$ 1–1.5 mm., equal, spores $5\text{–}7\ \mu$ diameter — *L. repanda* (Clements) Sacc.

17 Pileus incarnate-ochraceous, with zone of blue on margin, umbonate, subfibrillose, stem scaly downwards, equal, spores $6\text{–}8\ \mu$ diameter — *L. cyanozonata* Longyear

18 Gills white or whitish — 19

18 Gills lemon-yellow, edge serratulate, pileus lemon-yellow, with rufous scales, 1.5–2 cm., stem concolor, 2–4 cm. $\times$ 2–4 mm., scaly, spores $7\text{–}8 \times 4\ \mu$ — *L. citrophylla* B. & Br.-Boudier

19 Pileus or scales becoming tinged with vinaceous, or with lilac, rosy or rufous colors — 20

19 Pileus or scales becoming tinged with yellowish or brown colors — 24

20 Odor none or slight — 21

20 Odor strong, of coal tar, pileus white becoming lilac-tinted, minutely mealy, stem 5–7 cm. $\times$ 3–5 mm. changing to deep lilac when bruised, spores boat-shaped, $7\text{–}8 \times 3\ \mu$ — *L. Bucknallii* B. & Br.-Rea

21 Gills broad to very broad — 22

21 Gills narrow, stem tapering upward — 23

22 Spores 8–9 × 3 5 μ, oblong-ellipsoid, pileus umbonate, umbo reddish-tan, with few delicate floccose scales, 2 5–3 5 cm, stem equal, 7–9 cm × 2–4 mm *L amplifolia* Murrill

22 Spores 6 × 3 μ, oblong (Kauff), pileus umbonate, vinaceous-buff, 1 5–2 5 cm, umbo obtusely conic, densely flocculose, stem 2-5 (6) cm × 1 5–3 mm (Spores 3 5 × 2 μ Murrill) *L petasiformis* Murrill

23 Gills crowded, stem clavate, 8 mm thick below, fibrillose, up to 7 cm long, pileus 3 cm broad, white with rosy tint, subumbonate, spores 6–7 × 4 μ *L roseicinerea* Murrill

23 Gills not crowded, stem slender, 2–4 mm thick, 5–9 cm long, pileus 1 5–3 cm, umbonate, snow-white or rose-tinted, spores 7–8 × 3 5 μ *L subnivosa* Murrill

24 Stem 2–3 mm thick, pileus yellow-tinged 25

24 Stem very slender, scarcely 1 mm thick, 2–4 cm long, brownish below, pileus 1–2 cm, umbonate, minutely brownish-scaly, umbo dark brown, spores 5–6 × 3–4 μ *L nudipes* Pk

25 Spores 6–8 × 4 μ 26

25 Spores 4–5 × 3 μ, elliptical, pileus 1–2 cm, white, becoming yellowish when dry, pruinose, stem 1–2 cm × 2–3 mm, equal, fibrillose below the median annulus, on mosses and among grass in woods *L parvannulata* Lasch-Rea

26 Pileus pubescent-glabrescent, whitish or tinged yellowish-incarnate, umbo deeper yellowish, 1 5–2 5 cm, stem 5–7 5 cm long, subequal, annulus superior *L mesomorpha* Fr -Rea

26 Pileus at length with minute, pale yellow scales, not umbonate, 1 5–2 5 cm, stem 3–5 cm long, base slightly enlarged, annulus median (In drying the whole plant assumes a rich yellow hue) *L alluvina* Pk

IV SUBCLYPEOLARIAE

1 Spores fusiform or subtruncate-cuneate 2

1 Spores oblong, elliptical or ovoid 5

Taste slight or none 3

Taste strong of radish, pileus 3–6 cm, disk pale-yellowish, margin whitish and lacerate-scaly, stem 4–8 cm × 3–6 mm, bulb thicker, annulus at length lacerate and fugacious, spores fusiform 15–19 × 5–6 μ, among grass in fields *L erminea* Fr -Ricken

3 Spores not up to 12 μ long, subtruncate-cuneate 4

3 Spores 12–15 × 5–6 μ, subtruncate at one end, pileus small, 10–15 mm broad, scales chestnut-brown, stem 3–4 cm × 2–2 5 mm, clothed with chestnut-brown scales up to the annulus, flesh turning to brown when bruised, in woods *L geniculospora* Atk

4 Odor somewhat disagreeable, pileus 1–3 cm, scales reddish-brown, stem 4–5 cm. × 2–4 mm, cortex tinged pinkish, spores 6–8 × 3–4 μ *L cristata* Fr

4 Odor none, pileus 3–5 cm, scales dark tawny, gills becoming ochraceous at maturity, stem 3–6 cm × 3–6 mm, equal, concolor, spores 9–10 × 3 5–4 μ *L fulvella* Rea

5 Flesh or surface of plant changing color when bruised or in age 6

5 Flesh white, unchanging 15
6 Stem distinctly clavate or subbulbous 7
6 Stem equal, or tapering gently upward 10
7 Plant showing red, green and blue tints when handled, pileus 1-3 cm, at first rufous-umber, then with minute, reflexed scales, at length rimose, stem 3-5 cm long, at first white, gills broad, subdistant, spores 7-9 × 4-5 μ *L virescens* Morgan
7 Plant not exhibiting this reaction 8
8 Plant when young vinaceous-drab, scales of pileus, the stem and the edge of gills becoming blackish-brown in age (See emended description) *L brunnescens* Pk
8 Plant at first whitish, or brownish only on the disk of the pileus, becoming reddish-brown when handled, or blackish-brown when dried 9
9 Spores 8-9 × 6-7 μ, pileus 2 5-4 cm, with numerous, minute, scales, stem 3 5 cm long, 2-3 mm thick at apex, subbulbous *L multicolor* Murrill
9 Spores 6-8 × 4-5 μ, pileus 3-5 cm, cuticle not soon broken into scales, stem 5-7 cm long, 4-6 mm thick at apex, clavate (*L rufescens* Morgan) *L brunnescens* Pk
10 Spores not more than 9 μ long 11
10 Spores 9-12 × 5-6 μ, pointed at the ends, pileus 1-2 cm, yellowish rubescent, minutely, densely scaly, stem 3-5 cm × 2-3 mm, all parts becoming red or reddish in age *L maculans* Pk
11 Pileus even, or at most short substriate 12
11 Pileus sulcate on margin, scales at first pale yellow, umbo fulvescent, 2-4 cm, gills narrow, subdistant, stem 3-5 cm × 2-4 mm, rufescent, spores 5-6 × 3-4 μ *L flavescens* Morgan
12 Stem up to 17 cm long, drab color, in forest of Sequoia, California, pileus 3-4 cm, chestnut-brown, rufescent, glabrous to fibrillose, gills white, becoming rose-colored when bruised *L roseifolia* Murrill
12 Stem much shorter 13
13 Plant in all parts assuming blue tints when bruised or on drying, pileus 1-2 cm, scales brownish, stem 3-5 cm × 1 5-2 mm, annulus persistent, spores 7 × 5 μ, elliptic *L caerulescens* Pk
13 Plant not assuming blue tints 14
14 Fibrillose covering of pileus and stem changing very quickly, in the fresh plant, to flame-scarlet, when the plant is touched or disturbed, flesh and gills white, unchanging (See description) (*L subfelina?*) *L flammeotincta*, sp nov
14 Fibrillose scales, etc, of the pileus and stem, as well as the flesh, changing to reddish-brown then brown 12-24 hours after bruising, pileus 2-3 cm, granular or scaly, stem 3-5 cm × 4-5 mm, annulus median, spores 6-8 × 4-5 μ *L brunnescens* Pk
15 Stem peronately appressed-fibrillose or fibrillose-subscaly below the membranous annulus 16
15 Stem glabrous below the annulus 21
16 Pileus 3-6 cm broad, stem 4-6 (7) cm long 17
16 Pileus 2-3 cm broad, or smaller, stem 2-4 cm long 19

17 Edge of gills dark umber, scales of pileus small, umber-colored, stem peronate up to the annulus, median, gills narrow, spores 6–7 × 4 μ, among grass *L nigromarginata* Massee
17 Edge of gills concolor 18
18 Gills flavescent at maturity, pileus mouse-gray at first, scales bistre-colored, annulus superior, stem with appressed, white scales, later becoming bistre-colored, spores 6–7 × 3–4 μ *L scabrinella* Fr -Rea
18 Gills remaining white, pileus varying brown, purplish-brown to blackish-brown, at length squarrose-scaly, annulus large, stem fibrillose, thickened at base, 2–5 (6) mm thick, spores 6–7 5 × 4–5 μ *L felinoides* Pk
19 Pileus very small, scales blackish-brown, 5–10 mm broad, stem 1 mm thick, floccose-fibrillose, annulus conspicuous, under surface blackish-brown, spores 6–7 × 4 μ, in woods *L gracilis* Pk
19 Pileus 2–3 cm broad 20
20 Pileus when young purplish-lilac, scales at length fuscous, annulus median, stem 2 5–3 mm thick, its cortex rubellus, spores 4–5 × 2–2 5 μ *L lilacea* Bres
20 Pileus with continuous cuticle, rarely subscaly, pale umber to dark brown, gills broad, all parts tough, spores 4–5 × 3 μ *L neophana* Morgan
21 Pileus quite small, 5–20 (25) mm broad 22
21 Pileus 2–4 (5) cm broad 24
22 Stem solid, growing from wood, pileus 10–15 mm broad, with minute blackish scales, gills remote, annulus persistent, spores 5–6 × 3–3 5 μ *L phaeosticta* Morgan
22 Stem hollow, not on wood 23
23 Stem clavate, 5–7 5 cm long, 3–6 mm thick, pileus 1–2 5 cm broad, whitish, tinged isabelline, fibrillose-pubescent, spores 6–7 × 4 μ, in woods *L juniperina* Murrill
23 Stem equal, 2 5 cm long, 2 mm thick, pileus 1–2 cm broad, whitish, becoming rugulose, striate, gills narrow, spores 6–8 × 4–5 μ (Morgan) *L rugulosa* Pk
24 Spores 5–6 (7) × 3 μ 25
24 Spores 6–8 × 4–5 μ, pileus subrimose, not scaly, gray or grayish-brown, disk purple-tinged, stem 4–5 cm × 2–4 mm subequal *L Glatfelteri* Pk
25 Umbo of pileus conspicuous, black, scales deep flesh-color, margin striate, gills subdistant, stem 3–6 cm × 2–5 mm, equal *L incarnata* (Clements) Sacc
25 Umbo whitish, brownish or chestnut color 26
26 Pileus white, rarely brownish on umbo, fibrillose-subscaly, stem slender, 2–4 mm thick, annulus median *L miamensis* Morgan
26 Pileus covered with small, avellaneous to chestnut-colored scales, stem 3–10 mm thick, brown-tinted, annulus superior *L castaneidisca* Murrill

V CLYPEOLARIAE

1 Spores *fusiform or subfusiform* 2
1 Spores not fusiform 6
2 Pileus (2) 3–5 cm broad 3
2 Pileus 1–2 (3) cm broad 5
3 Spores 21–26 (30) × 5–6 (7) μ, gills narrow, pileus or scales cinnamon-brown (See description) *L fusispora*, sp nov
3 Spores rarely 20 μ long 4
4 Pileus subglobose, yellowish-tawny, stem stout, 6–10 mm thick, yellowish, densely clothed with erect white flocci up to the floccose annulus, spores 12–14 × 4–5 μ *L pratensis* Fr -Rea
4 Pileus floccose-scaly, creamy-yellowish, stem 3–6 mm thick, sheathed with a dense floccose tomentum up to the floccose annulus, spores 10–16 (18) × 4–6 μ *L clypeolaria* Fr Kauff
5 Pileus brownish, floccose-scaly, 1–2 cm , gills broad, rather distant, stem 1 mm thick, spores 11–13 × 4 5 μ *L floralis* Berk & Rav - Beardslee
5 Pileus or scales black, 2–3 cm , spores 8–10 × 3–4 μ, in conifer forest *L felina* Pers -Ricken
6 Spores projectile-shaped (i e , rounded-enlarged at one end, narrowed and pointed at the other) 7
6 Spores not projectile-shaped 9
7 Pileus 5–8 cm broad, silky, glabrescent, whole plant white, gills broad, stem 6–8 mm thick, annulus submedian, floccose-membranous, reflexed, striate above, spores 12–14 × 6–7 μ apiculus recurved *L alba* (Bres) Sacc
7 Pileus 1–2 (3) cm broad 8
8 Spores 9–11 5 (13) × 4–5 μ, gills or flesh turning brownish-red with age, pileus subglabrous to somewhat felty, 1–2 cm , brown to reddish-brown *L castanea* Quél Lange
8 Spores 7–8 × 3–4 μ, pileus and stem white to rose-tinted, changing to chestnut-brown on drying, stem 2–5 mm thick, collected in Washington state *L castanescens* Murrill
9 Spores truncate at one end 10
9 Spores ellipsoid to oblong 13
10 Spores truncate at apiculate end, so as to be minutely bicornate, 8–9 μ long 11
10 Spores truncate at broader end, narrowed to subcuneate at the other end 12
11 Edge of gills purple-pruinate, pileus 3–4 cm , fawn-color, densely and minutely scaly, annulus cottony, in conifer forests, subcaespitose *L Boudieri* Bres
11 Edge of gills concolor, pileus 1–2 cm , mammillate, finely tomentose or with fine reddish-brown scales, odor of balsam *L castanea* Quél -Bres
12 Spores 8–11 × 3–4 μ, pileus 1–2 5 cm , cinnamon-rufous to tawny See ("Comments ") *L acerina* Pk
12 Spores 6–8 × 2 5–3 μ, pileus 4–8 cm , brown to tawny-olive, dif-

fracted-scaly, gills rather broad, stem 4–6 cm × 5–8 mm, equal, subbulbous, scales concolor *L caloceps* Atk
13 Pileus 3–5 cm broad 14
13 Pileus usually less or up to 3 cm broad 15
14 Spores 8–11 × 5 μ, pileus alutaceous to brown, stem 4–6 cm × 5–8 mm, annulus lacerate and appendiculate *L spanista* Morgan
14 Spores 6–8 × 3–4 μ, pileus covered with small reddish brown scales and fibrils, stem 7–10 cm × 4–8 mm, annulus narrow, distant *L clypeolarioides* Rea
15 Spores 8–10 μ long 16
15 Spores 5–6 or 7–8 μ long 17
16 Stem about 1 *mm* thick, pileus flame-red, conic-campanulate, 1–1 5 cm, subscaly-fibrillose, annulus subcortinate, spores 8–10 × 4 5–5 μ *L ignicolor* Bres
16 Stem 3–4 mm thick, pileus flesh-color, scaly, convex, subumbonate, 1 5–3 cm, annulus inferior, fugacious *L helveola* Bres
17 Pileus or scales black, striate-sulcate on margin, 2–3 cm, stem slender, farinaceous-scaly, annulus median, band-like, spores oblong, 5 × ? *L nociphila* (Ell) Sacc
17 Pileus not black 18
18 In conifer forests, pileus 2–3 cm, covered with small, squarrose, rusty-brown scales, stem equal, 2–3 5 cm × 3–4 mm, floccose up to the floccose annulus, spores 7 8 × 3–4 μ *L forquignoni* Quél -Ricken
18 In frondose woods, pileus 1 5–2 5 cm, tawny-brown, stem 4–5 cm × 2–4 mm, with mycelial bulb, floccose-fibrillose, rufescent, annulus flocculose-subappendiculate, spores 5–6 × 3 μ *L umbrosa* Morgan

VI ASPERAE

1 Spores *minute*, 4–5 (6) × 2 5–3 μ 2
1 Spores longer, 6–8 (9) × 2 5–3 5 μ 6
2 Stem bulbous, or tapering upward, 4–6 (10) mm thick 3
2 Stem equal, slender, 2–3 mm thick 5
3 Pileus or warty scales white, faintly dusky in age, 2–4 cm, gills broad, stem tapering upward, 3–5 cm × 3–5 mm, flocculose-scaly, white, veil appendiculate *L gemmata* Morgan
3 Pileus or scales brown, fuscous or umber 4
4 Pileus 5–7 cm broad, tomentose then torn into papillate scales, which may disappear, gills reaching stem, forming a prominent collar, not forked, stem 5–7 cm × 6–10 mm, densely wooly-scaly, fuscous, odor of radish, in frondose woods Spores oval, 5–6 × 2 5–3 μ *L hispida* Lasch-Lange
4 Pileus 2–4 cm broad, hair-brown to olive-brown, with small, erect, pointed scales, gills narrow, sometimes bifurcate at stem, stem concolor, bulbous, spores 4–5 × 2–3 μ *L asperula* Atk
5 Odor of radish, pileus campanulate, mammillate, bay-brown, 1 5–2 cm, at length with fine hairy erect scales, flesh rosy-colored, veil silky-cobwebby, spores 4–5 × 2 5–2 8 μ (Lange), 6–7 × 3–3 5 μ (Quélet & Bernard) *L echinella* Quél & Bern.

5 Odor not of radish, gills narrow, pileus convex-plane, dark brown, covered by a copious brown tomentum and then by very dense and wooly, pointed scales, 1 5–2 5 cm, stem very tomentose, brown, spores 4 × 2–2 5 μ — *L eriophora* Pk

6 Stem glabrous or nearly so, veil arachnoid, very fugacious, pileus 5–7 5 cm broad, pale crust-brown, soon cracked into minute scales, spores subtruncate-oblong, 8 × 3 5 μ — *L Cortinarius* Lange

6 Stem adorned downwards by fibrils of veil and scattered dark, floccose scales — 7

7 Pileus 6–12 (15) cm broad, covered with brown or rufous-brown, erect, pyramidal soft warts or scales — 8

7 Pileus 2–5 cm broad, its cuticle breaking up into small, pointed, blackish-brown scales, gills ventricose-broad, simple, crowded, spores 6–8 5 × 3 5–4 μ — *L fuscosquamea* Pk

8 Gills forked, rather narrow, spores 6–9 × 2 μ — *L Friesii* Lasch

8 Gills not forked, crowded, spores 6–9 × 2 5–3 μ — *L aculaesquamosa* Fr

VII PROCERAE-ANNULOSAE

1 Spores large, (12) 14–18 μ or more in length — 2

1 Spores not reaching 14 μ in length — 9

2 Flesh white, unchanging — 3

2 Flesh becoming pink or reddish when bruised, annulus erect-flaring, externally brown at margin, probably fixed, pileus 5–7 5 cm, dark-brown, diffracted-scaly, stem 7 5 cm × 10–15 mm, subequal, not bulbous, spores 18–20 × 10–12 μ — *L emplastrum* Cke & Massee

3 Stem markedly bulbous at base, annulus mobile — 4

3 Stem tapering upward, scarcely subbulbous, annulus thin, erect-flaring, narrow, pileus pallid brown, disk reddish-brown, 8–15 cm, abruptly umbonate, spores 14–18 × 9–10 μ — *L gracilenta* Fr -Ricken

4 Pileus quite large, between 8–18 (20) cm, cuticle diffracted into large, irregular scales — 5

4 Pileus averaging smaller — 7

5 Cuticle of pileus brown to tawny-brown — 6

5 Cuticle of pileus whitish or tinged alutaceous, stem 20–30 cm long, bulb 3–4 cm thick, spores 12–16 × 9–10 μ — *L porrigens* Viv -Morgan

6 Pileus not umbonate, brown, scales shaggy-imbricate, 15–20 cm., stem 20–30 cm long, gills whitish, spores 12–17 × 8–10 μ — *L rachodioides* P Henn -Morgan

6 Pileus umbonate, rufous-brown to tawny-brown, 8–12 (15) cm broad, annulus thick, firm, its underside brown-scaly, stem with furfuraceous or small brown scales, 15–25 cm long, spores 14–18 (20) × 9–12 μ — *L procera* Fr

7 Pileus obtuse or obtusely subumbonate — 8

7 Pileus acutely umbonate, fuscous, diffracted-scaly, 3–6 cm., gills very remote, stem 7–10 cm × 3–4 mm, obsoletely scaly, spores 15 × 9–10 μ — *L mastoidea* Fr -Rec

8 Pileus glabrous or minutely floccose, margin excoriate, whitish with

brown disk, 7–10 cm , annulus fringed on margin, flaring, stem 8–12 cm × 6–12 mm , mealy-floccose, spores 12–16 × 8–10 (11) μ *L excoriata* Fr -Lange

8 Pileus delicately floccose scaly, white with ochraceous disk, 5–8 cm , annulus narrow, entire, spores 12–18 × 7 8 μ *L puellaris* Fr -Rea

9 Flesh changing color when bruised, usually to reddish or yellowish, annulus fixed 10

9 Flesh white, unchanging 17

10 Stem ventricose-fusiform, varying to bulbous with short pointed base 11

10 Stem either truly bulbous at base or tapering upward from base 13

11 Cuticle of pileus diffracted into rather large concentric scales, fuscous to brown with rufous tints which become more pronounced in age, gills flavescent, or tinged rufous, annulus apical, membranous, erect-flaring, then collapsing 12

11 Cuticle of pileus fawn-color, with minute blackish scales, gills becoming rose-color, rarely lemon-color, rubescent when bruised, annulus lacerate, very fugacious, with blackish scales on its lower surface, pileus 2–5 cm , spores elliptical, 6–7 × 4 μ (Massee) *L meleagris* Fr Rea (non Ricken)

12 Pileus 5–20 cm broad, spores 8–11 × 6–8 μ, *straw-colored to reddish* or purplish *L haematosperma* Bres

12 Pileus 4–8 (10) cm broad, spores 8–10 (10 5) × 5–7 (7 5) μ, white *L americana* Pk

13 Spores elliptical 14

13 Spores subglobose, 6–7 (10) μ in diameter, pileus and concentric squarrulose scales white, 3–10 cm , disk ochraceous, gills white, connected at inner end by a cartilaginous collar, flesh becoming pinkish under cuticle and at base of stem, stem attenuate upward from bulbous base *L nympharum* Kalchbr -Rea

14 Pileus robust, hemispherical, diffracted-scaly, scales large, shaggy, often revolute, gray-brown or bay-brown, 10–15 cm , gills very remote, annulus with lacerate margin, adhering for a long time to margin of pileus, stem 10–15 mm thick, bulb large, spores 9–11 (12) × 6–7 μ *L rachodes* Fr -Lange

14 Pileus thinner, scales minute 15

15 Spores small, 6–7 × 3–4 μ 16

15 Spores 10–12 5 × 6–7 5 μ, pileus 5–7 5 cm , umbonate, with minute scurfy, brown scales, striate on margin, stem tapering upward from enlarged base, 5–7 5 × 4–6 mm *L Earlei* Pk

16 Flesh or surface of pileus and stem becoming fuliginous on drying, pileus 8 cm , white with rosy tints, finely floccose scaly, stem long, twisted, tapering upward, gills distant *L fuliginescens* Murrill

16 Flesh turning saffron-red, finally black, pileus 5–12 cm , minutely scaly or hispid, stem bulbous, annulus sometimes submobile, spores straw-colored *L Badhami* B & Br -Rea

17 Spores white in mass 18

17 Spores green in mass, annulus mobile, pileus white, buff or brown, 10–20 cm broad, scaly, subexcoriate, stem hard, clavate below, 2–4 cm thick, spores 9–12 × 6–8 μ *L Morgani* Pk.

18 Stem solid, pileus 6–10 cm broad 19
18 Stem stuffed with fibrils or hollow 21
19 Pileus pallid clay-color, *annulus ample* 20
19 Pileus white, glabrous, margin even, stem subequal or subbulbous, 5–10 cm × 8–12 mm, taste and odor farinaceous, annulus large then subevanescent, spores globose, 4–5 μ *L solidipes* Pk
20 Pileus diffracted-scaly, scales rather large, stem 5–7 cm × 7–10 mm, spores 8–9 × 6–7 μ, in cultivated gardens, southern states *L hortensis* Murrill
20 Pileus floccose-silky, glabrescent, stem 5–10 cm × 10–12 mm, bulbous, spores 7–8 × 4–5 μ, in frondose woods *L holosericea* Fr -Ricken
21 Pileus colored rosy, pink, red or olive 22
21 Pileus white or slightly isabelline on disk 25
22 Pileus 4–7 cm or 6–12 cm broad 23
22 Pileus 2–4 cm broad, rose-lilac, livid on disk, minutely fibrillose-scaly, gills narrow, annulus sometimes mobile, ample, stem 7–10 cm × 2 5 mm, slender, spores 8–9 × 4–5 μ *L roseilivida* Murrill
23 Pileus olive, spores 5–6 × 3–3 5 μ (See description) *L olivacea*, sp nov
23 Pileus pinkish to red, subglabrous, *radially rimose*, annulus ample, fixed, membranous, stem equal or attenuate upward 24
24 Spores 8–10 × 4–5 μ, stem 4–9 cm × 4–6 (8) mm *L rubrotincta* Pk
24 Spores 7 × 3 5 μ, stem 10–15 cm × 5–10 mm *L rubrotinctoides* Murrill
24 Spores 5–7 5 × 3–4 5 μ, pileus 6–12 cm broad, stem peronate by a red, glabrous sheath up to the ample, flaring, thickish annulus (*L pulcherrima* Zeller) *L decorata* Zeller (non *L pulcherrima* Graff)
25 Pileus 4–8 (9) cm broad 26
25 Pileus 2–4 cm broad, finely fibrillose-scaly, gills narrow, stem 5–10 cm long, 3–5 mm thick, annulus persistent, spores 7–9 × 3 5–4 μ *L Sequoiarum* Murrill
26 Pileus abruptly umbonate, plicate-sulcate on margin, gills narrow, remote, stem 7–10 cm long, tapering upward from a bulbous base, 5–8 mm at base, annulus thin, spores 7–9 × 5–6 μ *L "mastoidea"* Morgan
26 Pileus convex, not umbonate, white, glabrous, gills changing slowly to dingy pinkish at maturity, stem 5–10 cm × 6–12 mm, tapering upwards from a thickened base, annulus in form of a rounded collar, spores 7–9 × 5–6 μ *L naucina* Fr

New and Emended Species of Lepiota *

Lepiota olivacea, sp nov (Plate XV)

Pileus fleshy, fragile, 4–7 cm broad, campanulate-expanded, soon plane or depressed, sometimes subumbonate, dry, cuticle

* The type specimens are deposited in the Herbarium of the University of Michigan.

innately and radially fibrillose, subpulverulent, even, "light grayish-olive" to "olive-gray" (Ridg) "dark olive" on disk, opaque, flesh thin, soft, white, unchanging, gills free, becoming remote, ventricose, 5–6 (7) mm broad, edge obscurely fimbriate, stem 5–6 (7) cm long, 3–5 mm thick at apex, equal or tapering slightly upwards, scarcely subbulbous, up to 10 mm thick at base, silky-stuffed then hollow, glabrous, even, white, silky-shining upwards, annulus median, terminating a thin evanescent sheath, membranous, at first erect-flaring, odor and taste none or slight, spores 5–6 × 3–3 5 μ elliptic-ovate, acute at one end, smooth, subhyaline and with a delicate incarnate tint under the microscope, uniguttate, basidia short, stout, 4-spored, 25–27 × 8 μ, cystidia none, sterile cells on edge of gills, ventricose above, 27–30 × 7–10 μ, often crystallate at apex

Growing scattered on low, alluvial soil under thickets of Sambucus and Impatiens Ann Arbor, Michigan August 14, 1921 Collected by C H Kauffman

Green or olive Lepiotas are rarely mentioned in the literature, *L virescens* Morgan and *L caerulescens* Pk are entirely different both by their color and spores Although I have received reports that *L Morgani* Pk is sometimes entirely green, that species is far removed from the one here described

Lepiota fusispora, sp nov (Plate XVI)

Pileus fleshy, 2–5 (7) cm broad, subcampanulate-expanded, subumbonate, at length plane or depressed around the umbo, dry, at first with a rather thick, soft, fibrillose, "cinnamon-brown" (Ridg) cuticle, which becomes broken into numerous, floccose, erect or recurved scales, arranged concentrically and showing the pale buff flesh between, not striate on the margin which is lacerate-floccose, flesh rather thin, soft, "warm-buff" towards surface, whitish near gills, gills free, reaching the stem by a point, rather narrow, 3–4 mm broad, subventricose, close, thin, white or with creamy tint, edge entire or nearly so, stem 4–6 cm long, 5–6 mm thick at apex, equal or incrassate downwards, up to 12 mm thick below, stuffed, cortex rather rigid and

hard, covered at first up to the annulus by the thick, floccose-fibrillose cinnamon-brown universal veil, which is then broken into thick, wedge-shaped scaly masses, which often disappear in part, annulus at first manifest, recurved, thick, plicate-striate from the gill-pressure, becoming evanescent, odor and taste none or slight, spores long, fusiform, acuminate-pointed at both ends, 18–25 (30) × 5–6 (7) μ, smooth, hyaline, cystidia none, basidia clavate, 4-spored, 55–60 × 10–12 μ, sterile cells on edge of gills indistinct, saccate

On very decayed wood or debris Type collected by Prof F C Stewart at Seventh Lake, Adirondack Mts, New York, September 1, 1921 Also in the Medicine Bow Mts, near Centennial, Wyoming, September 5, 1923 Collected by C H Kauffman

This is apparently a rare species, or perhaps usually confused with related ones The spores are surprisingly large, and are unique, one end is often drawn out to a needle-like prolongation It probably occurs in mountainous regions throughout the northern part of our country

Lepiota flammeatincta, sp nov

Pileus fleshy, 2–3 cm broad, campanulate-expanded, at length almost plane, obtuse or obsoletely umbonate, dry or nearly so, cuticle at first continuous and "tawny" (Ridg) or disk chestnut color, soon breaking up into numerous, small, appressed, fibrillose, tawny scales, sometimes subexcoriate, margin not striate, cuticle changing quickly to "flame-scarlet" when plant is picked or touched, flesh thin, about 1 5 mm, submembranous on margin, white, unchanging, except adjacent to cuticle, gills free, subremote, narrow, crowded, white, unchanging, stem 6–8 (10) cm long, 2 5–5 mm thick, tapering gently upwards, peronate at first by a somewhat tawny, fibrillose, often reticulate sheath, up to the annulus, fibrillose covering changing quickly to "flame-scarlet" (Ridg) when handled, whitish within, delicately stuffed by white fibrils then hollow, apex white and naked and unchanging, annulus membranous,

narrow, at first flaring then collapsing, tawny below, whitish above, tinged flame-scarlet when disturbed, odor none, taste slightly bitterish, spores 8–9 × 4–4 5 μ, subellipsoid-oblong, smooth, hyaline, cystidia none, basidia clavate, about 30 × 6–7 μ, sterile cells on edge of gills saccate

Oregon National Forest, Mt Hood, near Welch's, Oregon October 5, 1922 Collected by C H Kauffman

Whether this is *L subfelina* Murrill can not be definitely known After picking, the plants were laid exposed on a table, when the flame-scarlet tints disappeared and the tawny colors became again noticeable The flesh and gills do not possess the substance causing the change to red, only the cuticular covering (i e, the universal veil) of the cap and stem seem to possess this property

Lepiota cuneatospora, sp nov.

Pileus 1 5–3 cm broad, dry, at first obtusely oval, even and uniformly flesh-pink, at length campanulate-expanded, broadly mammillate, umbo pinkish, elsewhere paler to dull cream color, the cuticle glabrous, even or becoming rimulose, sometimes excoriate on margin, flesh white, thin, thickened at umbo, unchanging, gills free, approximate, somewhat truncate-rounded behind, rather narrow or of medium width, crowded, thin, whitish, stem 4–5 (6) cm long, 2–4 mm thick, equal, glabrous above and below the annulus, even, hollow, silky-shining, white, flesh-tinted or white within, annulus membranous, erect-flaring, superior or at least above middle of stem, distinct and often with thick edge, white or tinged pink on lower side, fixed or submobile, odor and taste slight or none, spores 7–9 × 3 μ, narrowly wedge-shaped, subtruncate at broad end, with scattered, obscure papillae, hyaline, cystidia none, sterile cells on edge of gills obscure, basidia clavate, about 28 × 6 μ Gregarious, or forming loose arcs like parts of fairy rings, on grassy ground in a grove of pine Takoma Park, Maryland July 22, 1919 Collected by C H Kauffman

The annulus at the time of its formation is continuous below with a very thin evanescent outer layer on the stem The non-

scaly cap and stem, the peculiar spores, and the distinct but delicate annulus are some of the distinguishing characters It is related to *L Boudieri* Bres and *L castanea* Quél Both of these have a scaly cap and stem, the first has a cottony annulus, the latter emits a fragrance of balsam From *L fulvella* Rea it differs in stature, color and its smaller spores

Lepiota brunnescens Pk (Emended)

Torrey Club Bull, 31 177 1904
Syn *Lepiota rufescens* Morgan Journ Myc, 12 246 1906

Pileus 2 4 cm broad, fleshy, thin, campanulate-expanded, nearly plane, subumbonate, cuticle at first "pallid vinaceous drab" (Ridg), soon breaking into concentrically arranged, vinaceous drab, subsquarrose, small, fibrillose scales, which soon become "blackish-brown" (Ridg), and alternate with the slightly colored flesh between, disk remaining even, glabrous and becoming blackish-brown, margin not striate, flesh thin, soft, whitish or tinged vinaceous, becoming blackened towards the margin of pileus, gills free, thin, crowded, "pallid-vinaceous drab," rather broad, ventricose, edge white-fimbriate but becoming blackish-brown, or stained blackish, stem 4 6 (7) cm long, 4–5 mm thick above, tapering upward from a subclavate base up to 9 mm thick, stuffed then hollow, cortex rather soft in texture, surface silky, "pallid-vinaceous drab" becoming blackish-stained in age or from handling, annulus median, membranous, at first erect-flaring, subpersistent, concolor, blackening in age, odor fungoid, spores 6–8 × 3 5–4 5 μ ellipsoid, subacute at one end, smooth, hyaline, cystidia none, sterile cells on edge of gills slender, sublanceolate

On leaf-mold in swamps and grassy woods, Great Falls of the Potomac, Virginia August 20, 1918

Originally described from St Louis, Missouri *L rufescens* Morgan, from Ohio, is referred to it by Murrill as a synonym, and this is undoubtedly correct Murrill reports it also from New York, New Jersey, and California To quote Dr Peck, "This singular species when fresh resembles *Lepiota cristata*, but

on drying the whole plant changes color" Since the colors and their changes have not been very accurately described, it seemed best to give a revised description here

Lepiota pulcherrima Graff (Emended) (Plate XVII)

Philippine Basidiomycetes II Philip Journ Sci Bot, 9 —— 1914
Syn *Lepiota candida* Morgan (non Copeland) Journ Myc, 12 202 1906
Limacella albissima Murrill, North Amer Flora, 10 40 1914

Entire plant white Pileus fleshy, 1–4 cm broad, at first subconic-campanulate, expanded-plane, obtuse, subviscid, pellicle thin and very bitter to taste, cuticle on drying sometimes becoming fine silky-scaly or minutely diffracted-scaly, margin not striate, flesh thin, white, unchanging, gills free, approximate, narrow, crowded, edge concolor and entire, stem 5–8 cm long, tapering gently upward, slightly subfusiform or subclavate, 2–4 mm thick at apex, 4–8 mm below, innately silky or fibrillose-scurfy below annulus, pruinose to glabrous at apex, stuffed with silky fibrils then hollow, annulus membranous, erect-flaring, narrow, superior, subpersistent, terminating a thin, evanescent sheath which is subviscid and bitter to the taste, odor none, spores small, 5–6 (7 5) × 3–3 5 μ, oval-elliptical, smooth, hyaline, often uniguttate, cystidia none, basidia clavate, 30 × 5–6 μ, hymenium sharply differentiated from gill-trama

Among forest debris on the ground, under mixed trees of maple, alder and conifers, Oregon National Forest, Mt Hood, near Welch's, Oregon September and October Collected by C H Kauffman and L E Wehmeyer

These plants had the color and other characters of *L pulcherrima* Graff (= *L candida* Morg) The very bitter taste of the surface of the pileus and stem in the growing condition, is, however, not known to be present in that species and I have omitted testing for it in collecting *L pulcherrima* at Ann Arbor The slightly shorter spores of the Oregon form is the only other difference I know of, those measure 5–6 μ long, while the spores of the Ann Arbor collection are up to 7 5 μ long It is, however, too close to the latter, and future observations may show that

the eastern plant is also provided with a bitter pellicle It is known to me from Ohio, Michigan and Oregon

The naming of this plant has become a slightly involved matter Morgan found it in Ohio and published it in 1906 as *L candida* Meanwhile Copeland had already used this name for a Philippine species in 1905 In the *North American Flora*, Murrill segregated it under *Limacella albissima* in 1914 Finally, the same year, Graff, in his account of Philippine fungi, renamed the plant, calling it *L pulcherrima* Since then, Zeller has named a red-capped Lepiota from Oregon *L pulcherrima*, but discovering the error, now suggests *Lepiota decorata* for his plant

Volvaria avellanea (Clem), comb nov (Emended)

Syn *Lepiota avellanea* Clem , Bot Surv Nebr , 2 41 1893
Volvaria concinna Clem , Bot Surv Nebr , 5 91 1901
Volvariopsis cincinna (Clem) Murrill, North Amer Flora, 10 142 1917

Pileus thin, fleshy, 1-3 (5) cm broad, at first oval to obtusely subconic and then uniformly "vinaceous-brown" (Ridg), minutely flocculose-fibrillose, with incurved margin, at length broadly campanulate, subumbonate, dry, with long subdistant striae on margin, the thin cuticle broken into numerous, radiating, appressed, delicate scales, "vinaceous-brown" on disk, scales concolor or paler, flesh white, submembranous, unchanging, gills free, rather broad, subdistant, white, becoming crisped on drying, edge minutely white-flocculose, stem 2-4 cm long, 1-3 (5) mm thick, at first conic then tapering slightly upward or equal, stuffed then hollow, slightly mealy or glabrous at apex, white above the inferior, sheathing, thinly membranous and closely appressed, "vinaceous-brown" volva, which frequently disappears early leaving its upper portion on the stem as a low-hung narrow annulus, odor none, spores oval or elliptic-oval, 9–11 (12) × 5–6 (7) μ, smooth, with rosy tints, cystidia none, sterile cells on edge of gills broadly saccate, obtuse, about 45 × 12 μ

In warm greenhouse, Washington, D C , growing on cocoanut fiber used as soil, or on soil itself, as *V concinna*, collected

on moist soil along a river in Nebraska, as *Lepiota avellanea*, on soil in a greenhouse in Nebraska

This plant, as it appears from time to time in a hothouse, is quite variable Sometimes the veil is more delicate and the lower part of the volva is not seen and only a slight, vinaceous-tinged annulus occurs The volva when present is long, cylindrical and sheathes the stem closely, and is easily overlooked, it is a unique volva The rosy tint of the spores is also easily overlooked The size of the plant varies quite a little under different conditions for its development I do not doubt that both the plants described by Prof Clements belong to the same species I frequently observed and studied it at Washington An error in the citation of the date of publication of *Lepiota avellanea*, as given in the *North American Flora*, Vol 10, page 58, would lead one to the wrong specific name to be applied

Comments on Certain Species of the Synopsis

Lepiota acerina Pk (Plate XVIII) — The slender habit of this plant is well shown in the photograph The veil covering is floccose, on the pileus it breaks into minute, soft scales which are "cinnamon-rufous" to "tawny" (Ridg), the stem is more or less reticulate from the veil, the minute flocculose scales occupying the connecting points of the reticulum The photograph was made from plants collected at Ann Arbor, August 14, 1921

Lepiota americana, L Badhami, L haematosperma and L meleagris — The general confusion concerning the identities of these four species seems to be promoted by each successive writer Bresadola (*Fung Trid*, 2 83) combined the first three species It now appears that *L americana* is distinguishable from *L haematosperma* by its white spores and smaller size If Rea's description of *L Badhami* is conclusive, then that species is mainly separable from *L haematosperma* by the flesh at length becoming black, by its truly bulbous instead of ventricose stem, and by its smaller size It is to be noted that *L haematosperma* Bull -Bres appears under the name *L meleagris* in Ricken's book, *L Badhami* is considered a synonym But

L. meleagris, the specific name of which was applied by Sowerby, ought to be known in England, if anywhere. Rea's account (13) of the plant therefore deserves attention. It appears to be relatively a much smaller plant than any of the others, the scales on the cap are minute and black, and the annulus is "very fugacious." It has no relationship to such species as *L. brunnescens* Pk. or *Psalliota echinata* Fr.

LEPIOTA ACUTAESQUAMOSA, L. ASPERA, L. FRIESII and L. HISPIDA.—What one is to believe among the conflicting opinions concerning the identity of these four species, is difficult to decide. Fries gives his mature opinion in *Hymen. Europ.*, 1874, where he recognizes the specific distinction of *L. acutaesquamosa* Weinm., *L. hispida* Lasch and *L. Friesii* Lasch. In a note under *Amanita aspera*, he refers to the Persoon species "*Agaricus asper*" as one involved in confusion. In *Monographia*, Vol. I (1857), p. 23, he says *L. Friesii* has not yet been collected in Sweden. Quélet and Battaille (12), on the other hand, recognize *Lepiota aspera* of Persoon, and practically make *L. acutaesquamosa* Weinm.-Fr. a synonym of it. They also recognize *L. hispida* Lasch, but do not mention *L. Friesii*. According to their descriptions, *L. aspera* has forked gills, while the gills of *L. hispida* are simple. Gillet, in *Champignons de France*, 1874, includes *L. acutaesquamosa* Weinm. and *L. hispida* Lasch and assigns to them simple gills, recognizing *L. Friesii* Lasch as a species with forked gills. Ricken (14) considers *L. acutaesquamosa* Weinm. as a synonym of *L. Friesii* Lasch, including only the latter and *L. hispida*. He gently brushes away certain difficulties by including in the description of each of these species the words "bisweilen gabelig." C. G. Lloyd (*l. c.*) also combines *L. Friesii* and *L. acutaesquamosa* by the use of the magic words "sometimes gills are not forked, sometimes few forked, and often many forked." Morgan (*l. c.*) recognizes Persoon's name, *L. aspera*, and reduces *L. acutaesquamosa* and *L. Friesii* to synonomy. Morgan's method of side-stepping the gill-character in question is to omit stating whether they are simple, forked or either. Rea (13) italicizes the word "branched" in describing the gills of *L. acutaesquamosa* and omits italics for it in *L. Friesii*

LEPIOTA FUSCOSQUAMEA (Pk) Sacc — In *Agaricaceae of Michigan*, p 633 , I reported a plant collected in northern Michigan, as *L felina* Fr This I now consider to be *L fuscosquamea* Pk I have since collected the latter species in the Adirondack Mountains, and am convinced that the spore size given by Peck is misleading, and should be 6–8 5 × 3 5–4 μ In the *North American Flora*, Murrill assigns spores to it, smaller even than the size given by Peck Lange (9) tried to unite this species with one he collected in Europe and which he considered to be *L hispida* Lasch The spore size of Lange's plant is given as 5–6 × 2 75–3 μ, and the shape oval, hence the two species cannot be combined Although it may be thought a fine distinction, it may be worth while to point out that the spores of *L acutaesquamosa* and *L Friesii* in this country, are constantly at least one micron less in width than in *L fuscosquamea* Its gills are simple The floccose covering on the stem is dense and breaks up into erect, conical, blackish scales This blackish color is distinguishing

LEPIOTA GRACILIS Pk and "LEPIOTA GRACILIS" Quél — Peck's name apparently antedates the use of the name by Quélet for his variety of *L clypeolaria* Both Lange (9) and Rea (13) seem to have missed this use as a varietal name, since they have raised Quélet's variety to the rank of a species, crediting Quélet with it (See *Flore Monographique des Amanites et des Lépiotes*, p 66) Peck's species is remarkable for the small size of the plant which is said to have a conspicuous, persistent, membranous annulus Lange (9, p 24) has described a plant which he calls *L gracilis* Quél var *laevigata* As indicated in the synopsis earlier in this paper, this deserves specific rank and is therefore renamed **L laevigata** Lange, comb nov

LEPIOTA MASTOIDEA Fr — This is another Friesien species not very well understood in Europe Since Rea gives the spore characters of the plant which he places here, we can look for it more confidently The plant described by Morgan (*Jour Myc* , 13 2, 1907) is at least not that of Rea, and probably is a distinct American species Bresadola (*Ann Myc* , 18 65 1920) considers *L porrigens* Viv a synonym of it Ricken (14) in-

timates that *L mastoidea* may be only a small form of *L gracilienta* The fact of the matter is, that various European writers pass along suggestions about a number of species of the Procerae group, but rarely make an exhaustive study of any of them

LEPIOTA PARVANNULATA (Lasch) Fr — A species scarcely if at all understood in this country According to Fries, "The only species with which it can be confused is *L erminea*, which agrees in color and is found in similar places (i e in grassy fields), but which is much larger and differs in the superior, torn annulus, the glabrous pileus and its odor of radish"

LEPIOTA SEMINUDA (Lasch) Quél This is hardly ever referred to by modern American collectors Bresadola makes the suggestion (*Ann Myc*, 18 64 1920) that *L cristatatella* Pk is identical By letter, he had given this opinion to Americans a long while before Atkinson (3) reproduces excellent photographs of it, from both French and American collections Murrill (*North American Flora*, 10 48) includes it In my opinion, it is nevertheless probable that two distinct forms occur In Michigan we have the typical form described by Peck, but farther south, especially around Washington, D C, I have collected a somewhat larger plant which fits the description and figures of *L seminuda* much better than it does that of the little *L cristatatella*

COMMENTS ON EXCLUDED OR DOUBTFUL SPECIES*

LEPIOTA ALBO-SERICEA P Henn — This name is used by Lange for a plant of which he gives a description He says it is likely that it is the same species as *L serena* Fr and is identical with the larger form of *L parvannulata* Fr

LEPIOTA ANGUSTATA Britz-Morg — This is too close to *L cristata* Fr

LEPIOTA ASPRATA Berk — Fries, in *Hymen Europ*, refers this to *Pholiota muricata* Fr

* No complete list of possible synonyms or exclusions among the older names, such as are mentioned by Saccardo, can be given here However, an attempt is made to include most of the names that have been used for discarded species in this country, as well as certain ones from Europe

LEPIOTA ARIDA (Fr) Gill is *Amanita arida* of the *Icones* of Fries Rea includes it among the Lepiotas, but it is surely a better Amanita

LEPIOTA ATROCROCEA W G Smith — No microscopic characters are reported for this species

LEPIOTA CONCENTRICA Murrill — Referred to *L fuscosquamea* Pk as a synonym by Murrill himself

LEPIOTA CULTORUM B & C — This species was named in 1853 from South Carolina, but has remained unknown to mycologists since that time

LEPIOTA DAUCIPES (B & M) Morg is more likely an Amanita

LEPIOTA DELICATA Fr was referred to the genus Armillaria by Boudier Rea reports it as having globose spores, 5–6 μ in diameter Schweinitz and Morgan reported the species from the United States

LEPIOTA DRYMONIA Morg — No specimens are in existence and its spore characters are unknown

LEPIOTA ECHINATA (Roth) Quél — This little species, with red-tinted spores, I have kept in the genus Psalliota (See *Agaricaceae of Michigan,* I 245)

LEPIOTA FRAGILLISSIMA (B & Rav) Morg — It was originally described in the genus Hiatula The spore characters are unknown

LEPIOTA FULVASTRA (B & C) Sacc — This species is too poorly known to be retained

LEPIOTA HAEMATOSPERMA (Bull) Boud is another name for *Psalliota echinata* Fr

LEPIOTA JANTHINA Cke — Ricken considers this to be the same as *L castanea* Quél

LEPIOTA MAGNISPORA Murrill — This was described by Murrill from the Northwest, in 1912, later he published it as a synonym of *L clypeolaria* Its spores were given as 15–18 $\times$ 4–5 μ in size, oblong-fusiform in shape

LEPIOTA MAMMAEFORMIS Underw — The type collection of this came from Alabama It is made a synonym of *L cepaestipes* by Murrill

Lepiota metulaespora B & Br. — A species described long ago from India European and early American mycologists referred certain of their collections to it, and the name has persisted in the literature up to within a few years It is now generally agreed that the name and the species have no place in the floras of Europe and North America It is therefore surprising to see it emerge once more in Lange's recent paper on the genus

Lepiota nardosmioides Murrill — This is an anomaly in the group The umber tint to the spores indicates that it needs further study It was found in a redwood forest in California

Lepiota pelidna (B & Mont) Sacc — This is not sufficiently understood The original plants grew on fallen trunks In spite of its habitat, it is very likely an Amanita

Lepiota permixta Barla — Rea who includes this in his book, gives its spore-size as 12-20 × 8-12 μ This spore-size is also given in Saccardo's *Sylloge* The original description of the spores suggests that it is probably not white-spored It is described from southern France

Lepiota pinguis Fr — The spore characters are unknown It was probably introduced into Sweden, since Fries collected it from pine wood not native to that country

Lepiota polypyramis (B & C) Morg. — Presumably an Amanita

Lepiota polysticta Berk — The minute globose spores, along with some other characters, suggest a different genus

Lepiota prominens F — Morgan and others consider this a synonym of *L porrigens*

Lepiota pyrenaea Quél is *Pholiota aurea* Fr , according to Maire

Lepiota radicata (Pk) Morg is *Amanita radicata* Pk

Lepiota serena Fr — This is one of the Friesian species about which little has become known Boudier suggests that it is *Armillaria subcava* Schum Bresadola makes *L brebissonii* Godey a synonym of *L serena*

Lepiota sistrata Fr — Not recognized as a rule by modern mycologists

LEPIOTA SORDESCENS B & C (as Agaricus) — Referred to *L cepaestipes* by Murrill

LEPIOTA SUBREMOTA B & C (as Agaricus) — This has apparently not been recognized since it was named Murrill refers it to *L cepaestipes*, while Morgan makes it a synonym of *L mastoidea* Fr

LEPIOTA SULPHURINA (Clements) Sacc — This seems to me, from its description, to have the characters of an Amanita with pulverulent volva

LEPIOTA VITTADINII Fr — Intermediate between the genera Lepiota and Amanita, verging toward the latter

LEPIOTA XYLOGENUS Mont — As shown by Murrill (*Mycologia*, 6 151 1914), there is no dependence to be placed on the meaning of the specific name in this case It was collected in Hawaii

UNIVERSITY OF MICHIGAN

LITERATURE CITED

1 ATKINSON, G F 1914 The Development of Lepiota clypeolaria Ann Myc, 12 346–356.

2 —— 1914 Homology of the "Universal Veil" in Agaricus Mycologisch Centrallbl, 5 13–19

3 —— 1916 The Development of Lepiota cristata and L seminuda Mem N Y Bot Gard 6 209–228

4. FRIES, ELIAS MAGNUS 1821 Syst Myc, I 19

5 —— 1857 Monographia, I 17

6. —— 1874 Hymen Europ, p 29

7 KAUFFMAN, C H 1918 Agaricaceae of Michigan, I 625

8 —— 1922 The Genus Armillaria in the United States and its Relationships Papers Mich. Acad Sci Arts and Letters, II 53–67

9 LANGE, JAKOB E 1915 Studies in the Agarics of Denmark, Part II Dansk Botanisk Arkiv, 2 13

10 MURRILL, W A 1914 North American Flora, 10 40–64

11 QUÉLET, LUCIEN 1886 Ench Fung, p 5

12 QUÉLET, LUCIEN, ET BATTAILLE, FRÉDÉRIC 1902 Flore Monographique des Amanites et des Lépiotes, p 44

13 REA, CARLTON 1922 British Basidiomycetes, p 64

14 RICKEN, A 1914 Die Blätterpilze Deutschlands, 1 314

PLATE XV

LEPIOTA OLIVACEA sp. nov.

PLATE XVI

LEPIOTA FUSISPORA, sp. nov.

PLATE XVII

LEPIOTA PULCHERRIMA

PLATE XVIII

Lepiota acerina

AN INJURIOUS FACTOR AFFECTING THE SEEDS OF *PHASEOLUS VULGARIS* SOAKED IN WATER

PAUL TILFORD, C F ABEL AND R P HIBBARD

INTRODUCTION

It is generally conceded that by soaking seeds one may hasten their germination, provided the period of soaking is not too long Thus an optimum period of soaking has been suggested for a number of different kinds of seeds [1] It has been shown that deleterious effects follow if seeds are soaked for longer periods than that which is the optimum Kidd and West [2] have reported that, in the first place, the percentage of germination, when the soaking was too long, was considerably below that of seeds not soaked Secondly, not only was the germination reduced, but the subsequent growth of the plant was affected The dry weight of month-old plants that had been subjected to prolonged soaking was considerably less than that of seeds planted dry Lastly, the nature of the effect was strongly specific, since different results were obtained by similar treatments on closely allied plants

These claims were made from a series of experiments with dwarf bean, broad bean, mustard, oat, lupin, wheat, sunflower and pea The seeds were soaked in water for periods of time varying from 6 to 72 hours (6, 24, 48, 72) They were removed from

[1] Ganong, W F 1908 *A Laboratory Course in Plant Physiology*, p 211 Henry Holt and Co

[2] Kidd, Franklin, and Cyril West 1918. *Physiological Predetermination The Influence of the Physiological Condition of the Seed upon the Course of Subsequent Growth and upon the Yield I The Effect of Soaking Seeds in Water* Ann Appl Biol, 5 1-10

the water at the periods indicated and placed on damp sand in porous pots covered above with glass, to germinate

Working with a great many kinds of seeds, such as pea (garden and field), dwarf bean, alfalfa, flax, sunflower, wheat, oats, rye, barley, clover, corn, mustard, radish and buckwheat, we have also obtained deleterious effects on prolonged soaking in tap water The effect has not been the same on the different kinds of seeds The experiments have shown that proteinaceous seeds as a class are more quickly injured than seeds that are predominantly starchy or fatty It is true also that different results are obtained by similar treatments on closely allied plants A short period of soaking (eight hours) injures the seed of the common navy bean (*Phaseolus vulgaris*) in our experiment as in those of Kidd and West [3]

Just what causes the breakdown in the seeds, the navy bean for example, is of course the interesting feature Although they have done no experiments in this direction, Kidd and West,[3] in a review of the literature, enumerate what others have so far given as reasons The suggestions fall into two classes There is either an accumulation of CO_2 with a consequent reduction of free oxygen, or an exosmosis or leaching of soluble food materials The former may be taken as an example of impaired respiration, leading to suffocation, while the latter may be called the starvation theory

When bean seeds are allowed to soak in a dish of water, the water soon loses its transparency and not very long afterward a very offensive odor is given off This odor is suggestive of bacterial action As bacteria are known to cause decomposition, it is natural to infer that the breakdown of seeds soaking in water is really attributable to bacterial activity A series of experiments was therefore outlined in an attempt to prove this These experiments are detailed below

[3] Kidd, Franklin, and Cyril West 1918 *Physiological Predetermination The Influence of the Physiological Condition of the Seed upon the Course of Subsequent Growth and upon Yield IV Review of Literature* Chap III *Ann Appl Biol*, 5 220–251

EXPFRIMENTATION

Experiment I

To establish the time when the seeds were injuriously affected by soaking in water, the following experiment was set up Approximately eleven hundred bean seeds were placed in a two-quart Mason jar, which was then filled with tap water After six hours, and after each subsequent six-hour period up to seventy-eight hours, one hundred seeds were taken out and placed in proper conditions for germination The temperature of the water was that of the room, about 20 degrees Centigrade The following table shows the germination obtained

TABLE I

GERMINATION PERCENTAGES AT DIFFERENT TIME-PERIODS IN STAGNANT WATER FOR PHASEOLUS VULGARIS

Time in hours in stagnant water	0	6	12	18	24	30	48	72	78
Germination percentage	98	95	80	50	20	15	10	0	0

From the table it may be observed that some lowering of germination took place even earlier than six hours and that a very decided drop took place between the sixth and twelfth hours Finally at the end of forty-eight hours the germination fell to 10 per cent After the beans were soaked for two days, the resulting liquid gave off an odor, which at the end of three days was still more offensive The liquid was opaque and only the seeds in a layer near the sides of the jar were visible The conditions in this jar focused attention on the bacterial factor

A uniform method for germinating the seeds was adopted and consisted in placing them between two or three folds of wet paper toweling, packed on wet quartz sand in shallow wooden trays These were placed in the greenhouse where the temperature varied from 18° C to 24° C The bean seeds were from a disease-free stock (Robust) raised on the College farm and

showed a high percentage of germination, varying with different samples from 97 per cent to 100 per cent

Experiment II

The next experiment was planned in an attempt to minimize the bacterial factor About fifteen hundred seeds were placed in the Mason jar, the mouth of which was covered by a piece of cheese-cloth securely fastened by a string This cloth served to retain the seeds, but allowed the water to flow freely A long-stemmed thistle tube was thrust through a hole in the cheese-cloth and pushed to the bottom of the jar, when this was placed under the spigot and the water turned on, fresh water was added to the bottom, while the old water flowed over the top of the jar In this way, the seeds were soaking in running water As in the previous experiment, one hundred seeds were taken out at definite periods and set out to germinate The percentage of germination is shown in the following table

TABLE II

GERMINATION PERCENTAGES OF PHASEOLUS VULGARIS AT DIFFERENT TIME-PERIODS IN RUNNING WATER

Time in hours in running water			12	18	24	30	48	72	78	98	117	126	132	144
Germination percentage	100	98	100	100	98	94	93	87	81	82	52	44	37	20

In this particular test, provision had to be made to maintain the temperature of the running water at the same point as that of the room, for running water is about 10° C lower This was done by heating a long twisted coil of metal tubing through which the water passed, in a gas flame

It will be noted from this table that the percentage of germination does not fall as rapidly, nor does loss of viability appear as early, as in seeds soaked in stagnant water It may be concluded, however, that the loss of viability takes place, but

after a longer period of soaking than in the first test In this method the beneficial effect may have come from the removal of the CO_2 and other by-products and the renewal of free oxygen

Experiment III

The previous experiments have minimized the bacterial factor, but the question may now be asked, How will the percentage of germination be affected if bacteria are entirely eliminated? Disinfected seeds were soaked in sterile water under sterile conditions for varying periods of time Hand-picked seeds from disease-free samples of Robust beans were disinfected as follows The seeds were first treated with alcohol for a few minutes and then with 1 1000 $HgCl_2$ for twenty minutes These seeds, in lots of 100 each, were transferred, in a culture room and under the customary conditions, to flasks of sterile water (sterilized in the autoclave at fifteen pounds pressure for one hour) At no time during the course of the experiment did the liquid in the flask become cloudy, nor did several attempts at plating samples from each of the flasks at the termination of the experiment show any bacterial or fungous colonies The results are indicated in Table III

TABLE III

GERMINATION PERCENTAGES FOR PHASEOLUS VULGARIS AT DIFFERENT TIME-PERIODS IN STERILE WATER

Time in hours in sterile water	0	50	72	96	126
Germination percentage	97	54	30	25	15

Under the conditions of the experiment, the percentage of fermination finally falls to a low point, although it is better at the end of one hundred and twenty-six hours in this non-agitated sterile water than in stagnant water This decline in viability is no doubt due to an accumulation of CO_2 and to an absence of sufficient oxygen to provide for the life-processes within the seed

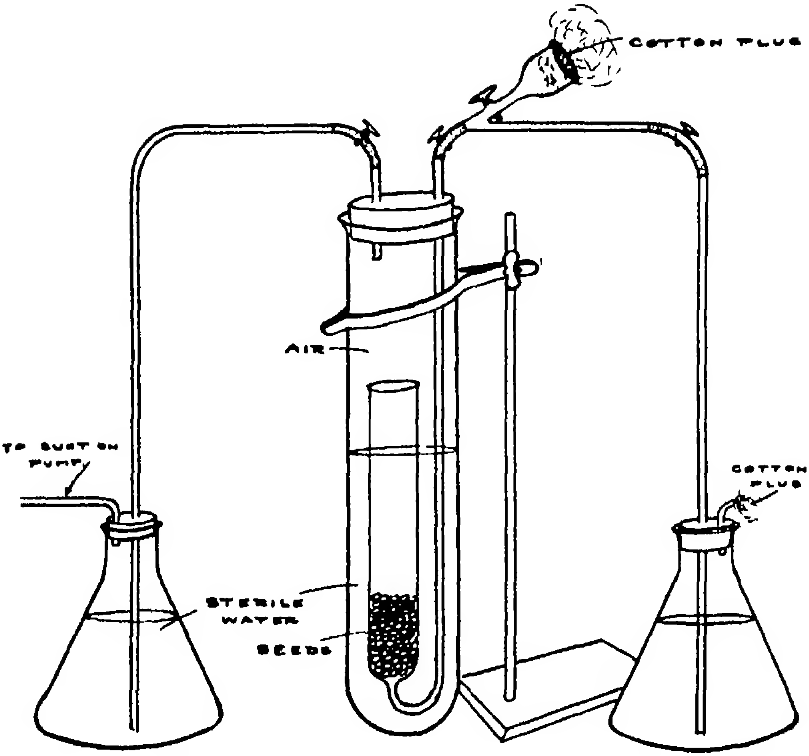


Fig 8 Apparatus for Soaking and Aërating Beans under Sterile Conditions

Experiment IV

It follows from the results of the experiments mentioned above that the next logical step in the study should provide for a renewal of oxygen (air) and a removal of CO_2 under sterile conditions With the set-up, as shown in the accompanying diagram, Figure 8, the conditions of the experiment were met The seeds were selected and disinfected according to the method already outlined The final step in the process, the disinfection with $HgCl_2$, was carried on within the apparatus previously sterilized in the autoclave at 15 pounds pressure for half an hour The disinfectant was washed out with sterile water by suction, and then a fresh supply of sterile water in which the seeds might soak was introduced To provide for aération, the apparatus was attached to the suction pump and air was sucked through for three to five days as the case might be To show that the air entering the apparatus contained no bacteria, a similar set-up was attached to the suction pump Instead of seeds soaking in water, this time, the larger test tube held some beef agar at the bottom At no time during the five-day period of exposure did a bacterial or fungus colony show on the agar slant As a control for the original experiment, a similar number of seeds were soaked in tap water in an open test tube like the one shown in the diagram Of course, this was not aërated Accordingly, another large test tube was set up containing water and seeds and attached to the suction pump The air inlet on this apparatus was not plugged with cotton and the sources of bacterial contamination were within and without the apparatus The results of the germination test under the three treatments indicated are found in Table IV.

TABLE IV

GERMINATION PERCENTAGES OF PHASEOLUS VULGARIS UNDER THREE DIFFERENT METHODS OF TREATMENT

Treatments	Germination percentages at end of 72 hours		
	1st test	2d test	3d test
Sterile aërated	60–72 *	97–100 *	50–88 *
Non-sterile aërated	14–0	37–40 *	23–27 *
Non-sterile stagnant	20–0	0–0 *	0–0 *

From this experiment the conclusion that bacterial activity is a large factor in the breakdown of bean seeds is inevitable The mention of a few observations during the course of the experiment may not be out of place here In about six hours the two aërated cultures had produced a foam or frothy mass at the top of the liquid This frothy mass seemed to occur sooner in the non-sterile aerated culture than in the sterile aerated one and also seemed to be more abundant Furthermore, the water became cloudy sooner in the non-sterile aérated culture than in the sterile aérated one Just what caused this difference is not known, but it might be suggested that more CO_2 was being formed there It is very likely that more bacteria or fungi were present than at first Whether they entered from without or became more numerous because of the aëration is not known, but either alternative might be a possible explanation In order to determine whether or not CO_2 was present and a factor, the CO_2 content by volume was ascertained for each of the three liquids At the same time an H ion concentration determination was made for each solution The pH values were determined electro-titrometrically by means of the Bartell potentiometer The CO_2 content by volume was gained by the use of

* After the percentage of germination under water had been determined, the seeds were removed and placed under good conditions for germination to determine how many more would germinate The numbers starred give the final germination scores

the Van Slyke apparatus for the determination of CO_2 The results are found in Table V

TABLE V

CO_2 AND H ION CONCENTRATION VALUES FOR THE THREE LIQUIDS OBTAINED IN THE FOREGOING EXPERIMENT

Test No	Sterile aerated		Non-sterile aérated		Non-sterile non-aërated	
	pH	CO_2	pH	CO_2	pH	CO_2
1	6 0	3 4	4 6	31 7	4 6	20 6
2	6 4	6 1	7 07	7 90	4 3	13 28
3	6 3	3 4	7 20	12 36	6 9	19 53

It is evident from the table that CO_2 increases progressively Slight amounts are found in the sterile aérated culture, more in the non-sterile aerated, and most in the non-sterile, non-aërated culture In the non-sterile aerated culture,[4] the first test shows a high CO_2 content This is evidently too high a value and all out of proportion to the other two (tests 2 and 3) Except for a few discrepancies the table shows that CO_2 is an important factor and that where the cultures are neither aerated nor sterile, there is the greatest accumulation of CO_2

DISCUSSION OF RESULTS

If bean seeds are allowed to soak for three days in a large volume of water which is at rest in a dish, an offensive odor develops The condition is indicative of bacterial action This is what causes the breakdown and the loss of germination and not the soaking process *per se* As a result of bacterial activity the bean seeds rot before they germinate, that is, bacterial products kill or weaken the embryo The problem that Kidd and West dealt with is, therefore, connected with bacterial decom-

[4] These tests and determinations were made by Dr C S Robinson, associate chemist of the Experiment Station

position, suffocation or CO_2 poisoning brought about by their technique of experimentation Bean seeds under water are not injured by the soaking, but can be made to germinate as well as in soil

If the bean seeds are soaked in running water, either at room temperature or at the temperature of the running water, the bacterial factor is minimized No odor is present at any time up to the end of the experiment (seven days), nor are the seeds soft and mushy as in stagnant water Germination persists at a high level for a longer period This effect, obtained in running water, is no doubt due to the constant renewal of oxygen and the withdrawal of CO_2 and other by-products

It may be shown, possibly, in both the foregoing cases, the one where the seeds were soaked in a large volume of water at rest, and the other where the seeds were soaked in running water, that the final loss in viability may come, in part, from a leaching or an exosmosis of soluble foods from the seeds The writers are at present unable to show that leaching is not a factor They are emphasizing the bacterial factor because of its greater significance

The greater benefit obtained in the running water and in the cases where there is volume per volume of seeds and water, over that of seeds soaking in larger volumes of water is very likely due, as various authors have suggested, to the renewal of oxygen and the removal of CO_2 This does not, however, remove the possible influence of the exosmosis of soluble foods

Now if disinfected seeds, free from disease, are soaked under sterile conditions, germination takes place after a longer period than when they are soaked in stagnant water For example, in stagnant water, samples of beans from the general stock germinate at the rate of 10 per cent in forty-eight hours In seventy-two hours there was no germination at all In sterile water, disinfected clean beans germinated at the rate of 54 per cent at the end of fifty hours and still were better than 10 per cent at the end of the experiment or one hundred and twenty-six hours This clearly shows the part played by bacteria

In this particular experiment no special provision was made

for removing the products of respiration, nor for establishing the proper environmental conditions for the life-processes of the seeds When, by the simple method of aeration, proper conditions can be provided, it is possible to bring about 97 per cent germination after a period of three days under water If seeds soaking in water could always obtain sufficient oxygen to carry on respiration, if all the CO_2, and other by-products could be efficiently disposed of, and if bacteria were absent, then we might reasonably expect, other things being equal, that germination would depend only on the capacity of the seeds to germinate Under these conditions, germination under water would be as good as in the soil

When we observe the high percentage of germination at the end of three days of soaking under aërated sterile conditions and when we note further that only after several days in running water, does the germination rapidly fall, the foregoing conclusion must be very probable to say the least

CONCLUSIONS

The experiments detailed above lead to the following conclusions

1 *Phaseolus vulgaris* seeds under certain conditions (soaking in stagnant water) will rot before they will germinate, that is, bacterial products will kill or weaken the embryo The injurious effect is not due to the soaking *per se*

2 Disinfected beans free from organisms can be made to germinate as high as 87 per cent after even a prolonged period of soaking in running water at 20° C

3 When disinfected clean seeds are soaked in sterile water under sterile conditions, germination can be as high as 54 per cent at the end of forty-eight hours and still be capable of germination at the end of one hundred and twenty-six hours

4 When disinfected clean seeds are soaked in sterile distilled water under sterile condition and vigorously aërated by means of a suction pump, germination can be as high as 97 per cent even after three days under water

5 One may reasonably expect bean seeds to germinate equally well under water as in the soil, provided there are sufficient oxygen for respiration, an efficient means of disposing of CO_2 and other by-products, and a complete absence of decomposing bacteria

MICHIGAN AGRICULTURAL COLLEGE
EXPERIMENT STATION
EAST LANSING, MICHIGAN

GENETIC STUDIES IN LYCOPERSICUM

I THE HEREDITY OF FRUIT SHAPE IN THE GARDEN TOMATO *

PAUL ALANSON WARREN

INTRODUCTION

THIS paper presents field observations bearing upon the heredity of fruit shape in the common garden tomato, *Lycopersicum esculentum* Mill, together with a simple Mendelian hypothesis which explains the heredity of several fruit types, and an analysis of data recorded by previous investigators in the light of the hypothesis suggested

PREVIOUS MENDELIAN STUDIES IN THE GENUS LYCOPERSICUM

Previous Mendelian studies in the genus *Lycopersicum* account for the heredity of nine characters on a monohybrid basis In a list (See Table I) revised from the data of Halsted (1905) and Price and Drinkard (1908), Jones (1917) gives eleven such characters involving various parts of the plant, and including two fruit shape characters, but with certain reservations as to the validity of the assumption that fruit shape is determined in any case by a single pair of factors The original data of Price and Drinkard are meager and are not considered by the authors themselves as conclusive proof of the monohybrid nature of the types recorded Groth (1912, 1915) and Crane (1915) find difficulty in classifying the various shapes which segregate in F_2 progenies of crosses between varieties differing in fruit shape, and assume that several factors are involved Groth (1915),

* Paper from the Department of Botany of the University of Michigan, No 217

in fact, arrives at no particular conclusions as to the interpretation of his own data, except that Mendelism is inadequate to account for the behavior of thousands of plants in his gardens, and that a stimulus imparted to the soma by the germ plasm must be invoked to explain the "Golden Mean" in F_1 and the chaos in F_2 Emerson (1917) has shown that the phenomena observed by Groth may be explained by the theory of multiple factors

Preliminary observations upon the character of fruit produced in 1919 by homozygous strains of ten garden varieties indicated (1) that each variety produces a fruit of definite shape and size, (2) that the fruits of some varieties are deep, those of other varieties shallow, (3) that the fruits of certain varieties are fasciated, i e, they represent a fusion of two or more ovaries, those of other varieties non-fasciated, and (4) that each fruit shape represents a separate combination of the unit characters, deep and shallow, fasciated and non-fasciated These observations have since been confirmed by field records and quantitative data upon the progeny of all parent strains and many crosses

Deep fruits are easily distinguished from shallow fruits without resorting to the caliper Fasciated fruits are distinguished from non-fasciated fruits either by their shape or, more accurately, by the nature of the flower scar Appropriate crosses have been made and fruit shape records of more than seven thousand plants are here presented, which seem to indicate that deep and shallow, fasciated and non-fasciated hitherto unrecognized as unit characters, are indeed such Furthermore, it has been possible to identify the factors which determine them Deep fruits are produced by the complementary factors *A* and *B*, non-fasciated fruits by the complementary factors *F* and *E*

If this hypothesis be accepted, it is no longer possible to assume, with Price and Drinkard, that any fruit shape (e g, roundish-conic) is a unit character The data here presented are not in accord with any multiple factor hypothesis, since there is always distinct segregation in the F_2

Material and Methods

ORIGIN AND DESCRIPTION OF THE VARIETIES INVESTIGATED

Ten strains of tomato, representative of all fruit shapes found among garden varieties, were selected and crossed Progeny of the parent strains and the F_1 and F_2 generations from crosses were grown in 1920 and 1921 In Table II are shown the pedigrees of all parents and crosses

All of the strains were obtained from the Jerome B Rice Seed Co through the kindness of Mr Wilber Brotherton, manager of the Detroit branch, to whom the writer is greatly indebted for coöperation in many ways With the exception of Bolgiano and Discovery, these strains have been under observation for years by Mr George Starr, plant breeder for the Company, at the Grass Lake Stock Seed Farm To him the writer is under obligation for supplying strains of known history and great uniformity These with the exception of Discovery have proved homozygous for all characters Although Mr Starr does not practice artificial pollination, his method of selection involves sufficient isolation to preclude the possibility of the accidental introduction of pollen foreign to the variety Artificial self-pollination of each strain, in some cases to the fourth generation, has failed to reveal a single segregating character in all but the single variety mentioned

A brief detailed description of each variety follows The classification is in accord with the depth-fasciation hypothesis and the genotypic formula is supplied here for later reference

I Varieties with deep, non-fasciated fruits

1 Early Detroit, *AABBFFEE*

A homozygous strain of this variety has been under observation for four generations The fruit is pink, deep (Globe type) and always non-fasciated The name of the variety is misleading The plants produce fruit very late in the season

2. Discovery It is impossible to assign a formula to this

variety The plant used in the original cross was of the formula *AaBbFfEe*

Of all varieties, Discovery is the most irregular Except for stature, leaf margin and fruit color, the strain was heterozygous when received The behavior in heredity of the variety indicates that it may have resulted from a recent cross between a Globe type and a member of the Earliana, Bolgiano June Pink group Seed was sent to Mr Brotherton by Lottentot and Huber, seedsmen, and large cultures have been grown at Ann Arbor and at Grass Lake with the same result, a splitting into two or more types in each generation The typical Discovery fruit is deep, non-fasciated

II Varieties with deep, fasciated fruits

1 Ponderosa, *AABBffee*

Ponderosa is a well known late variety with deep, much fasciated, pink fruit The plants are exceptionally large, a characteristic which is usually associated with late fruit production

2 John Baer, *AABBFFee*

John Baer is especially prolific and early The fruits are red, deep, usually fasciated, but never of the tremendous size of those in Ponderosa

3 Imperial, *AABBFFee*

Imperial is a very late variety, erect in habit, very vigorous in growth, producing deep, pink fruits, similar to those of John Baer, but of better quality

III Varieties with shallow, non-fasciated fruits

1 Dwarf Stone, *aabbFFEE*

A very late variety, Dwarf Stone produces rather small red fruits on erect, vigorous plants

IV Varieties with shallow, fasciated fruits

1 Bolgiano, *aabbffEE*

A potato-leaf red-fruited variety, lauded by its discoverer,

Bolgiano, for its extreme earliness, was sent to Mr Brotherton in 1919 with permission to employ it for breeding purposes Several plants were furnished to the writer in the spring of 1920 It proved to be as early as the Rice Company's best strain, Earliana As in all early varieties, the habit of the plant is low and sprawling, the leaves are small and the fruits much smaller and more inclined to sun-cracking than those of the later, more vigorous types Each plant produces a preponderance of shallow, non-fasciated fruits, but always a number of shallow, fasciated fruits

2 Earliana, *aabbffEE*

A homozygous strain, selected for the shape, texture and color of fruit as well as for earliness, Earliana is very similar to Bolgiano, differing only in that the leaves have serrate margins

3 June Pink, *aaBBffee*

June Pink owes its name to the combination of earliness and pink (i e , red endocarp and colorless epicarp) fruit color The habit is low and sprawling That there is a certain relationship between this variety and the large-fruited variety Ponderosa is evidenced by two facts, (1) the leaves of both varieties are crinkly at the edges and (2) a plant producing fruit identical with that of Ponderosa appeared in the cultures in the summer of 1921 as a mutation The fruits are shallow, but much fasciated

4 Dwarf Champion, *aabbffee*

The strain under observation is extremely uniform Unlike the other varieties it produces ripe fruit in the middle of the season The fruits are pink, very shallow and fasciated in about the same percentage as in Bolgiano The plants are of dwarf stature, grow rapidly, and soon lop over to the ground

METHOD OF POLLINATION

The methods of pollinating the flowers and of growing the cultures may be outlined briefly The tomato flower, normally self-fertilized, is easily emasculated and pollinated The young

peduncle is very fragile, however, and it has been found convenient to depart from the usual custom of protecting the pollinated flower with paper bags and to resort to the use of two-inch squares of heavy tissue paper The paper is formed into a cap, securely wired over the pollinated flower, and allowed to remain until the style has fallen, usually about four days Emasculation and pollination are accomplished at the same time A young flower is selected from the pollen parent, the pollen extracted and applied with a pollinating knife immediately after the flower of the staminate parent has been emasculated

METHOD OF HARVESTING SEED

Seed are harvested from the ripe fruits as follows After the desired measurements are made, the fruit is cut transversely through the center and a record taken of the number of locules The pulp is squeezed out into water in a battery jar and the mass mixed thoroughly A bit of inoculum from a jar containing fruit pulp which has been allowed to ferment in water for several days is added After a day the fermented mass is washed with a stream of water in a piece of cloth suspended over a cylinder of wire screen and the seed spread out on paper towels to dry

WINTER AND SUMMER CULTURES

Since it is desirable to have the cultures of all generations of a series in the gardens at the same time, winter cultures in the greenhouse are grown merely to produce seed Crosses are usually made in the garden Progeny from the parents and a few F_1 plants are grown in the greenhouse for self-pollination In the spring the seed from the parents, the seed remaining from the original crosses and the seed obtained from the F_1 plants, are planted for the field cultures In this way it has been possible to study an extra generation on a large scale each year and to base all conclusions on plants grown in the garden

In order to grow plants in the winter in the latitude of Ann Arbor with the assurance of ripe seed in time for the spring planting, it is necessary to resort to extreme forcing methods.

The plants are grown in a mixture of one part sand and two parts loam to prevent an excess of vegetative growth Each plant is watched closely for the appearance of the first flower cluster, and the necessary pollinations are made at once The energy of the plant is now directed to the rapid development of ripe fruit by the frequent removal of new clusters and vegetative growth which may appear

Cultures in the greenhouse are limited to about four plants each Field cultures are much larger More than seven thousand plants were grown in the gardens in 1921. The ideal series of cultures for each cross consists of (1) each parent, A and B, one hundred plants, (2) F_1 pedigrees to include the reciprocal crosses, $A \times B$ and $B \times A$, each fifty plants, (3) F_2 pedigrees, $A \times B$, self-pollinated and $B \times A$, self-pollinated, each seventy-five plants and (4) back-crosses, each one hundred and twenty-five plants Such a series of cultures has not always been grown for each of the crosses, in some cases because of lack of time to make thorough observations More important series are always given precedence

ALTERNATIVE METHODS OF INVESTIGATION

Two avenues of approach are open to an investigator of the heredity of size and shape in the higher plants If the material be favorable, a direct classification of the parents, F_1 and F_2 segregates, may be made, if unfavorable for such a classification, large series of measurements are necessary In the former case the validity of the interpretation of the results is dependent upon the magnitude of the observable differences between the classes In the latter case, since there are no distinct classes, the data must be analyzed biometrically, and the value of the interpretation, speculative in great measure, depends upon the individual skill of the investigator in the treatment of the observed adherence to or departure from the Gaussian distribution, as an index to the behavior of the unit characters

Ample proof of the truth of these generalities is presented in previous papers upon the heredity of size and shape in the

tomato Price and Drinkard (1908) have arrived at certain conclusions as to fruit shape by the method of direct classification Groth's statistical methods have led him to conclusions which have brought severe criticism (Emerson, 1917) The earlier writers observe the types of fruit, and conclude that there is a definite Mendelian interpretation to be placed upon the observed segregations, the later writer becomes involved in a labyrinth of frequency distributions derived from individual fruit measurements, and comes to the conclusion that none of the neoteric developments of Mendelism are of avail in the explanation of the observed phenomena

In the present investigation both methods have been employed Many plants have been classified as to the depth and fasciation of their fruits by direct observation In certain cultures the weight and size of the fruits have been determined. These quantitative data confirm the accuracy of the former method in every case Only such constants derived from them as are needed for the purpose of definition will be presented here It is proposed to publish these data in full in papers devoted entirely to discussions of the quantitative measurement of fruit size in relation to the depth-fasciation hypothesis, to hybrid vigor and allied phenomena

The Results of Hybrid Segregation

Ratios among the F_2 segregates from crosses between the several varieties do not conform to a monohybrid hypothesis Attempts to explain the observed ratios on a dihybrid or polyhybrid basis, involving dominance, have also failed If the following pairs of complementary factors are assumed to be operative in the determination of the types of fruit observed in F_1 and in the F_2, it is possible to explain every phenomenon which has thus far been observed in the crosses

FACTORS FOR DEPTH AND FASCIATION

A, a factor which alone produces shallow fruits, but which in the presence of *B* produces deep fruits

a, the normal allelomorph of *A*, produces fruits slightly more shallow than *A*

B, a factor which alone produces shallow fruits, but in the presence of *A*, deep fruits

b, the normal allelomorph of *B*, behaves as *a*

F, a factor which alone produces fasciated fruits, but in the presence of *E*, non-fasciated fruits

f, the normal allelomorph of *F*, alone produces much fasciated fruits

E, a factor which alone produces fasciated fruits, but in the presence of *F*, non-fasciated fruits

e, the normal allelomorph of *E*, behaves as *f*

Combinations of the factors suggested determine the shape of the fruit as follows

Group	Genotype	Phenotype	Shape
1	*ABFE*	Deep, non-fasciated	Deep-round
2	*ABFe*, *ABfE*, or *ABfe*	Deep, fasciated	Deep-round or Deep-oval
3	*AbFE*, *aBFE*, or *abFE*	Shallow, non-fasciated	Shallow-round
4	*AbFe*, *abFe*, *abfe*, *AbfE*, *abfE*, *aBfE*, *aBFe*	Shallow, fasciated	Shallow-round or Shallow-oval

As a result of the behavior of each of the ten varieties in crosses, it has been possible to assign to each the complete genotypic formula given with the variety descriptions

The factors for non-fasciation behave in a manner which has not yet been suggested *F* in the presence of *E* always produces a non-fasciated fruit Either of these factors, however, in the homozygous condition (*FF* or *EE*) inhibits fasciation to a slight degree For example, in Bolgiano, Imperial and John Baer the presence of *EE*, *FF* and *FF* respectively inhibits the complete fasciation found in June Pink and Ponderosa The factors *A* and *B* may behave in a similar manner

In Table III are given all of the possible combinations of the four pairs of factors *A*, *a*, *B*, *b*, *F*, *f*, and *E*, *e*, with the progeny to be expected from self-fertilized plants of each genotypic constitution All of the varieties fall into the first four groups of Table III and breed true for their individual types ex-

cept the variety Discovery This variety gives progeny which may fall into any of the sixteen groups An individual plant of this variety which was used in certain crosses was of the formula *AaBbFfEe* Upon self-pollination it gave a close approach to the ratio 81 deep, non-fasciated 112 shallow, non-fasciated and fasciated 63 deep, fasciated

The actual ratio is	90 1	97 3	68 5
The deviation is	9 1	14 6	5 5
The probable error is	9 5	9 0	8 8
The Dev / P E is	1 0	1 6	0 6

By the χ^2 method, χ^2 = 951 and P = 799331

CLASSIFICATION OF CROSSES

The crosses which were used to test the foregoing hypothesis fall into the following groups, arranged in accordance with the order of Table III

1 Crosses in which the F_1 falls into one of the first four groups of Table III and in which there is no segregation for fruit shape in F_2 (Crosses I–VI)

I Bolgiano × June Pink
II Bolgiano × Earliana
III Earliana × June Pink
IV Dwarf Champion × Bolgiano
V Dwarf Champion × June Pink
VI Ponderosa × John Baer

2 Crosses in which the F_1 falls into Group 5 of Table III, namely, those in which the F_2 segregation is 3 deep, fasciated 1 shallow, fasciated (Cross VII)

VII June Pink × Ponderosa

3. Crosses in which the F_1 falls into Group 8 of Table III, namely, those in which the F_2 segregation is 3 shallow, non-fasciated; 1 shallow, fasciated (Cross VIII)

VIII Bolgiano × Dwarf Stone

4 Crosses in which the F_1 falls into Group 9 of Table III,

namely, those in which the F_2 segregation is 9 deep, non-fasciated 7 deep, fasciated (Cross IX)

IX Ponderosa × Early Detroit

5 CROSSES in which the F_1 falls into Group 10 of Table III, namely, those in which the F_2 segregation is 9 deep, fasciated 7 shallow, fasciated (Cross X)

X Bolgiano × Ponderosa

6 CROSSES in which the F_1 falls into Group 14 of Table III, namely, those in which the F_2 segregation is 27 deep, non-fasciated 21 deep, fasciated 9 shallow, non-fasciated 7 shallow, fasciated (Cross XI)

XI Early Detroit × June Pink

7 CROSSES in which the F_1 falls into Group 15 of Table III, namely, those in which the F_2 segregation is 27 deep, non-fasciated 21 shallow, non-fasciated 9 deep, fasciated 7 shallow, fasciated (Crosses XII–XIII)

XII Bolgiano × Early Detroit
XIII John Baer × Dwarf Stone

8 CROSSES in which the F_1 falls into Group 16 of Table III, namely, those in which the F_2 segregation is 81 deep, non-fasciated 63 shallow, non-fasciated 63 deep, fasciated 49 shallow, fasciated (Crosses XIV–XVII)

XIV Early Detroit × Dwarf Champion
XV Bolgiano × John Baer
XVI Ponderosa × Dwarf Stone
XVII Imperial × Bolgiano

9 CROSSES in which the F_1 falls into several groups because of the heterozygosis of one of the parents and in which the segregation in the F_2 depends upon the genotypic constitution of the self-pollinated F_1 individual (Crosses XVIII–XXI)

XVIII Discovery × Ponderosa
XIX Discovery × Bolgiano
XX Discovery × Earliana
XXI Discovery × June Pink

The F_2 ratios from all of these crosses are presented in Table V The genotypic formulae of many varieties have been determined by several crosses A record of all genotypes investigated is presented in Table IV It is evident from the situation which obtains in the first group above, that the genotypic constitution of Bolgiano, June Pink, Earliana and Dwarf Champion could not be discovered by any series of crosses within the group Crosses between these varieties and the six remaining varieties under observation have brought forth the interesting segregation phenomena observed in the last nine groups

TESTS FOR GOODNESS OF FIT

Before each cross is discussed in detail, a word must be said as to the tests applied for goodness of fit of the Mendelian ratios of Table V In all cases the probable errors have been calculated by the orthodox modification of the $\sqrt{npq}$ formula for the standard deviation(σ) In this method the

$$P\ E = \pm 0\ 67449 \sqrt{\frac{\qquad}{n}}$$

where P E is the probable error, N a particular term of a Mendelian ratio, K the sum of all the terms of such a ratio, and n the total number of individuals involved in the classification Such a procedure involves the assumption that the standard deviation of a ratio is equal to $\pm \sqrt{N\ (K-N)}$, a sufficiently valid assumption in any case, provided the number of observed individuals is large, certainly of value in the consideration of such ratios as 1 1 and 9 7, even though the number of individuals be comparatively small Wherever possible, i e, in such ratios as 48 9 7 and 144 63 49, in which more than two terms are involved, the probability (P) of the occurrence of such a ratio as a result of random sampling has been calculated by the χ^2 method of Pearson in which

$$\chi^2 = \Sigma\left(\frac{(m - m_1)^2}{m}\right),$$

where the expression $\Sigma\left(\frac{(m - m^1)^2}{m}\right)$ signifies the sum of all such terms as the square of the difference between the observed fre-

quency and the theoretical frequency, divided by the theoretical frequency The probability integral (P) is calculated from Elderton's *Tables for Goodness of Fit* (Pearson, 1914) Constants derived by this method are given in the text in the discussion of the crosses

Discussion of Crosses

1 Crosses in which the F_1 falls into Groups 1–4 of Table III and no segregation takes place in the F_2 generation

I Bolgiano, *aabbffEE* × June Pink, *aaBBffee*
F_1 = *aaBbffEe*

The parents as well as the F_1 and F_2 generations in this cross produce shallow fasciated fruits June Pink has deeper fruits than Bolgiano because of the presence of the factor *B* in the homozygous condition, more completely fasciated, consequently heavier fruits than Bolgiano because of the absence of the inhibiting factors *EE* The F_1 fruits are intermediate in both depth and fasciation These differences have been measured and found significant It is impossible by direct observation to record the small differences in depth and fasciation brought about by the factors *B* and *E* alone These must be treated in another paper devoted to the presentation of quantitative data

II Bolgiano, *aabbffEE* × Earliana, *aabbffEE*
F_1 and F_2, *aabbffEE*

The genotypic formulae here given have been determined from other crosses The varieties Bolgiano and Earliana bear identical types of fruit No differences possible of record by direct observation have been found in the fruits of the parents, the F_1 or the F_2 in this cross

More than three thousand fruits have been measured in this series in a separate investigation of hybrid vigor and these data will be presented elsewhere

III Earliana, *aabbffEE* × June Pink, *aaBBffee*
F_1, *aaBbffEe*

Obviously this cross involves the same genetic possibilities as the cross Bolgiano × June Pink The result is the same No segregation occurred in the F_2 The quantitative data are strictly comparable to those in the former cross

IV Dwarf Champion, *aabbffee* × Bolgiano, *aabbffEE*

F_1, *aabbffEe*

Forty-six plants of the F_1 and 151 plants of the F_2 were grown, mainly for the purpose of testing linkage between the potato-leaf and dwarf characters, a matter which will be discussed in another paper

None of the fruits were measured The parents, the F_1 and the F_2, are all shallow and more or less fasciated

V Dwarf Champion, *aabbffee* × June Pink, *aaBBffee*

F_1, *aaBbffee*

The F_1 generation with 64 plants, the F_2 with 148 plants, the back-cross June Pink × (June Pink × Dwarf Champion) with 124 plants and the back-cross Dwarf Champion × (June Pink × Dwarf Champion) with 124 plants have all failed to produce any fruits not to be expected from the foregoing formulae The fruits vary somewhat in size but are all fasciated and are all shallow In the F_2 generation it was possible to make a rough classification into 106 bearing slightly deeper and 42 bearing slightly shallower fruits The ratio is 2 9 1 1, a close correspondence to the 3 1 ratio expected from the segregation of *Bb* in the F_1 No such classification was attempted in the back-crosses

VI Ponderosa, *AABBffee* × John Baer, *AABBFFee*

F_1, *AABBFfee*

Ponderosa is a deep-fruited variety in which every fruit is fasciated, generally to the extent of producing exceedingly large misshapen fruits John Baer is also deep-fruited and the fruits are somewhat fasciated, but never to the degree observed in Ponderosa, a fact which is accounted for by the presence in John Baer of the *F* factor in the homozygous condition Eight

plants of the F_1 produced fruits which were also deep, but intermediate between the parents in fasciation, as would be expected in the heterozygous (*Ff*) type

In F_2 it should be possible to make a rough classification on the basis of fasciation alone All plants bear fasciated fruits The difference is one of degree, as would be expected by the presence in this generation of plants 25 per cent of which are homozygous for *F*, 50 per cent in the *Ff* condition and 25 per cent in the *ff* condition It has not been possible to differentiate two of these classes The *ff* class, however, is fairly distinct from the others and the field records show 24 such plants to 75 of the *Ff* and *FF* plants, a ratio of 0 97 3 03 The difference is 0 26 times the error and insignificant (See Table V)

In the back-cross Ponderosa × (June Pink × Ponderosa), which should give by the same classification a ratio of 1 1 between the plants which bear more fasciated and those which bear less fasciated fruits, the ratio 61 49 or 1 11 0 89 was found In this case the difference is 1 70 times the error and likewise insignificant (See Table V)

In the back-cross John Baer × (John Baer × Ponderosa), all of the individuals ought to fall into the less fasciated class of the foregoing classification, as they were indeed found to do in a record of 186 plants

It is rarely possible to observe the small differences recorded in this cross between offspring from plants of the formula *Ff* or *Ee* As will be seen directly, the F_2 segregation is dependent mainly upon interaction of the factors *F* and *E* to prevent fasciation and of the factors *A* and *B* to produce deep fruits It may be objected that, after all, the hypothesis suggested to account for the heredity of depth and fasciation is little more than a manipulation of a series of factors which have only a cumulative effect That such an objection is not a valid one, and that, although the factors *A*, *B*, *F* and *E* may exhibit a cumulative effect to a certain degree, such an effect cannot account for the profound differences observed when the pairs *A* and *B*, *F* and *E* meet in a zygote, will be seen in the crosses about to be discussed.

2 Crosses in which the F_1 falls into Group 5 of Table III, namely, those in which the F_2 segregation is 3 deep, fasciated 1 shallow, fasciated (Cross VII)

VII June Pink, *aaBBffee* × Ponderosa, *AABBffee*

F_1, *AaBBffee*

The genotypic formulae in this series indicate that all of the individuals should bear fasciated fruits, and, since no *F* nor *E* factor is present, very much fasciated fruits In all, 128 plants of the parent Ponderosa, 118 of June Pink, 95 of the F_1, 132 of the F_2, 129 of the back-crosses to Ponderosa, and 436 of the back-crosses to June Pink, a total of 1038 plants, has been grown All of these plants have produced fasciated fruits The reason for such an extensive series of cultures may be briefly outlined In the opinion of the seedsmen June Pink and Ponderosa are closely allied varieties The former is an early variety and produces smaller fruits, the latter a mid-season, sometimes considered a late variety, which produces the largest tomatoes known Both varieties have crinkly leaves A type similar to Ponderosa has appeared by mutation from June Pink It would seem of particular interest to determine whether such a relationship could be assumed to bear upon the general shape and size of the fruits

The first cross was made in 1919 The F_1 and F_2 cultures from this cross were grown in the 1920 garden The series presented what appeared at first to be a case of blending inheritance The cross was repeated and a second series including duplicates of the first series and in addition three F_2 cultures from the original cross were grown in the 1921 garden Again the F_1 and F_2 cultures seemed to be so nearly alike that no attempt was made to classify the F_2 plants as to fruit shape and the fruits were recorded as intermediate The importance of such a classification was not realized, in fact, until the present hypothesis had been worked out with other crosses and the formulae of June Pink and Ponderosa established

A second perusal of the 1920 data brings to light several interesting facts which were not before considered important.

Twenty-six plants in the F_2 of that year are recorded as Ponderosa, six plants as June Pink, a ratio of 3 25 0 75 (See Table V) A 3 1 ratio is to be expected, since the F_2 falls into four equal classes, three of which have the factors *AABB* or *AaBB*, and one the factors *aaBB* The three former classes are deep, corresponding to Ponderosa, the latter class shallow, as in June Pink

Three F_3 cultures were grown in 1921 from the foregoing F_2, one from a plant recorded as June Pink (i e , shallow, fasciated), and two from plants recorded as Ponderosa (i e , deep, fasciated) The former culture produced fruits which were recorded as intermediate It is likely that close attention to this culture would have revealed a 3 1 segregation The last two cultures were undoubtedly from the plants of the formula *AABBffee*, since they contained only large plants which produced typical, deep, fasciated Ponderosa fruits

The back-crosses, June Pink × (June Pink × Ponderosa) and (June Pink × Ponderosa) × June Pink, grown in 1920, showed a segregation into 142 plants with fruits recorded as Ponderosa or " deep June Pink " to 123 plants with fruits recorded as " true June Pink," a ratio of 1 07 0 93 (See Table V) From the hypothesis the segregation should be in the ratio 1 deep, fasciated 1 shallow, fasciated It is possible that some of the June Pink plants may have been recorded as Ponderosa, thus accounting for the excess of the latter plants in the ratio A classification with regard to depth in fasciated fruits is sometimes difficult to make without actually measuring the fruits

The back-crosses, Ponderosa × (June Pink × Ponderosa) and (June Pink × Ponderosa) × Ponderosa, have produced deep, fasciated fruits exclusively, according to expectation

3 Crosses in which the F_1 falls into Group 8 of Table III, namely, those in which the segregation is 3 shallow, non-fasciated 1 shallow, fasciated (Cross VIII)

VIII Bolgiano, *aabbffEE* × Dwarf Stone, *aabbFFEE*
F_1, *aabbFfEE*

The parents, together with the F_1 and F_2 plants of this series

should all produce shallow fruits Among 110 plants of the Bolgiano parent, 99 plants of the Dwarf Stone parent, 4 plants of the F_1 and 87 plants of the F_2, no deep fruits have been found Segregation in F_2, independent of factors for depth, depends entirely upon the behavior of the *F* factor in the presence of the *E* factor, and is thus 3 non-fasciated 1 fasciated The segregation is 58 29, a ratio of 2 67 1 33 The deviation is 2 66 times the probable error and of little significance (See Table V)

4 Crosses in which the F_1 falls into Group 9 of Table III, namely, those in which the F_2 segregation is 9 deep, non-fasciated 7 deep, fasciated (Cross IX)

IX Ponderosa, *AABBffee* × Early Detroit, *AABBFFEE*
F_1, *AABBFfEe*

The cross Ponderosa × Early Detroit offers the first example of a 9 7 ratio resulting from the interaction of the two factors *F* and *E* to inhibit fasciation completely

Ponderosa plants all produce much fasciated fruits, Early Detroit and the F_1 cross, non-fasciated fruits The parents, as well as the F_1 and F_2 plants are all homozygous for the *A* and *B* factors, so that all fruits throughout the series are deep In F_2 the segregation should be in the ratio 9 deep, non-fasciated 7 deep, fasciated A total of 183 plants of this generation was well classified during the summers of 1920 and 1921, 112 of which produced deep fruits with no suggestion of fasciation while 71 produced fruits fasciated in varying degrees The observed ratio is 9 79 6 21 The deviation is 2 00 times the probable error and probably insignificant (See Table V)

No question may be raised as to the accuracy of the classification in the F_2 from this cross Attention has been called to the difficulty of recording the types of fruit when a segregation involves the *B* factor or the *F* factor alone No such difficulty is encountered when the *A* and *B* factors or the *F* and *E* factors are both present, or both absent in the F_2

5 Crosses in which the F_1 falls into Group 10 of Table III, namely, those in which the F_2 segregation is 9 deep, fasciated 7 shallow, fasciated (Cross X)

X Bolgiano, *aabbffEE* × Ponderosa, *AABBffee*

F_1, *AaBbffEe*

The Bolgiano parent is less fasciated than Ponderosa because of the presence of *EE* The F_1 generation comprising 120 plants produced fruits of the general character of Ponderosa in depth, but with less fasciation because of heterozygosis of the *E* factor

The F_2 plants all produce fasciated fruits according to expectation A segregation possible of record in the field on the basis of depth alone gives a close approximation to the 9 7 ratio expected from the F_1 formula, *AaBb* Fruits from 129 plants were recorded as deep, fasciated, from 70 plants as shallow, fasciated, a ratio of 10 37 5 63 The deviation from expectation is 3 62 times the probable error Such a deviation might be considered a significant one were it not for the fact, mentioned in the discussion of the cross June Pink × Ponderosa, that it is difficult to classify fasciated fruits as to depth Further mention of the results of measuring many fruits in this series will be made in another paper It is really remarkable, in view of the difficulty of classification, that such a close approximation to theory was obtained as that recorded

6 Crosses in which the F_1 falls into Group 14 of Table III, namely, those in which the segregation in F_2 follows the ratio 27 deep, non-fasciated 21 deep, fasciated 9 shallow, non-fasciated 7 shallow, fasciated (Cross XI)

XI Early Detroit, *AABBFFEE* × June Pink, *aaBBffee*

F_1, *AaBBFfEe*

Early Detroit, 125 plants, produced deep, non-fasciated fruits, June Pink, shallow, much fasciated fruits All fruits on 21 F_1 plants were deep, non-fasciated

In the F_2 cultures no attempt was made to distinguish between deep and shallow fruits Certain plants producing deep, fasciated fruits, the Ponderosa type, were observed The record shows that 63 plants produced non-fasciated fruits and 69 produced fasciated fruits The ratio 27 21 9 7 resolves itself into a ratio of 9 non-fasciated 7 fasciated, if depth of fruit is disre-

garded The observed ratio is 7 64 to 8 36 The deviation is 2 93 times the probable error

The F_2 segregation in this cross is very striking No easier task presents itself in the tomato garden than that of recording fasciated and non-fasciated fruits by direct observation Further investigation may add numbers of plants to the record, but the present ratio furnishes sufficient proof for the necessity of assuming complementary factors for fasciation in these cultures

7 CROSSES in which the F_1 falls into Group 15 of Table III, namely, those in which the F_2 segregation is 27 deep, non-fasciated 21 shallow, non-fasciated 9 deep, fasciated 7 shallow, fasciated (Crosses XII, XIII)

XII Bolgiano, *aabbffEE* × Early Detroit, *AABBFFEE*

F_1, *AaBbFfEE*

The parent characters have been discussed (pp 360–361) The F_1 plants, 45 in number, produced typical Early Detroit fruits, deep and with no fasciation

No attempt was made to classify the non-fasciated fruits as to depth in the F_2 cultures Considering fasciation alone the 27 21 9 7 ratio, above, becomes the ratio 48 16, or 3 non-fasciated 1 fasciated In the F_2, 61 plants produced non-fasciated fruits and 34 plants fasciated fruits, a ratio of 2 57 1 43 It is evident that such a classification should produce the concordant results reported for this cross The deviation is 3 60 times the error (See Table V)

An attempt was made to classify as to depth of fruit the plants which produced fasciated fruits This classification, as mentioned before, is difficult The result, however, was not unsatisfactory With the non-fasciated fruits unclassified and the fasciated fruits classified as to depth the foregoing ratio becomes 48 deep, non-fasciated + shallow, non-fasciated 9 deep, fasciated 7 shallow, fasciated The observed frequencies were 61 18 16, a ratio of 41 10 12 13 10 78 The goodness of fit of this ratio is shown in Table V By the χ^2 method, $\chi^2 = 4$ 193 and P is 1250578 The differences shown in Table V are not of

great significance when the numbers of individuals and the difficulties in classification are considered

XIII John Baer, *AABBFFee* × Dwarf Stone, *aabbFFEE*

F_1, *AaBbFFEe*

The John Baer parent produces deep, somewhat fasciated fruits, the Dwarf Stone parent, shallow, non-fasciated fruits In F_1, 45 plants produced deep, non-fasciated fruits

In this case the classification of the fruits as to fasciation in F_2 is complicated by the presence of Dwarf plants upon which fruits fasciated to a marked degree seem never to appear The plants were consequently classified as to depth of fruit alone The ratio 27 21 9 7 becomes on this basis the ratio 9 deep, fasciated + deep, non-fasciated 7 shallow, fasciated + shallow, non-fasciated The observed frequencies were 72 66, a ratio of 8 35 7 65 The deviation is 2 12 times the error and insignificant (See Table V)

8 Crosses in which the F_1 falls into Group 16 of Table III, namely, those in which the F_2 segregation is 81 deep, non-fasciated 63 shallow, non-fasciated 63 deep, fasciated 49 shallow, fasciated (Crosses XIV to XVII)

XIV Early Detroit, *AABBFFEE* × Dwarf Champion, *aabbffee*

F_1, *AaBbFfEe*

The cross involves two parents homozygous for all factors The F_1, 25 plants, produced deep, non-fasciated fruits No F_2 cultures were grown

XV Bolgiano, *aabbffEE* × John Baer, *AABBFFee*

F_1, *AaBbFfEe*

The parents have been discussed above (pp 360–361) The F_1 plants, 81 in number, produced small, deep, non-fasciated fruits It is unfortunate that time did not permit a large series of fruit measurements in this generation An opportunity is here presented to study quantitatively a pedigree in which the

A and *B*, and the *F* and *E* factors are all in the heterozygous condition The fruits were small as indicated above, but just how much the actual size is affected by such a combination of factors is unknown

The F_2 plants were not classified as to depth A sharp segregation was observed between the plants producing non-fasciated and those producing fasciated fruits The record shows 96 of the former and 52 of the latter plants, a ratio of 10 49 to 5 51 (See Table V) As to fasciation alone the ratio 81 63 63 49 becomes 144 112 or 9 non-fasciated 7 fasciated The deviation is 3 39 times the error

XVI Ponderosa, *AABBffee* × Dwarf Stone, *aabbFFEE*
F_1, *AaBbFfEe*

The F_1 plants, 27 in number, produced, as in the preceding crosses, deep, non-fasciated fruits, smaller than the typical Ponderosa fruits

In the F_2 the segregation was similar to that of the preceding cross (Bolgiano × Dwarf Stone) Plants with non-fasciated fruits numbered 43, those with fasciated fruits 30, a ratio of 9 43 6 58 The deviation from the expected 9 7 ratio, is 0 68 times the error and insignificant A further classification of the F_2 plants with fasciated fruits shows 22 with deep fruits, i e , of the Ponderosa type and 8 with shallow fruits The ratio 81 63 63 49 becomes 144 63 49 on this basis The close agreement of theory and observation is shown in Table V By the χ^2 method, $\chi^2 = 3\ 081$ and P = 2160186

XVII Imperial, *AABBFFee* × Bolgiano, *aabbffEE*
F_1, *AaBbFfEe*

Considerable quantitative data upon fruits from all generations of this cross are to be published in another paper

Fifty F_1 plants produced typical, deep, non-fasciated fruits

The segregation in F_2 and the close agreement of observation and theory are shown in Table V The χ^2 test for goodness of fit gives for χ^2 the value 672, for P the value 866441 The fit is much better than would be expected from the classification of

98 plants This cross is especially important since the whole hypothesis of complementary factors for depth and fasciation of tomato fruits was suggested by the segregation of the F_2 (Imperial × Bolgiano) into four types of fruit, one a typical Ponderosa, the second a typical Bolgiano, the third a typical large Globe type and the fourth a tiny Globe fruit which had not yet been observed by the writer The first is deep, fasciated, the second, shallow, fasciated, the third, deep, non-fasciated and the fourth shallow, non-fasciated

9 Crosses in which the F_1 falls into several groups (Table III) because of the heterozygosis of one of the parents The F_2 segregation depends upon the genotypic constitution of the self-pollinated F_1 individual (Crosses XVIII–XXI)

At this point the consideration of crosses which are of especial importance in establishing the suggested hypothesis ceases The following crosses illustrate the employment of the hypothesis in the analysis of varieties of unknown constitution The variety Discovery, as has been mentioned earlier in the paper, was for a long time a most puzzling one Seed obtained by self-pollination produced plants bearing a motley array of fruit types Mr Starr recently informed the writer that he had tried unsuccessfully to "fix" the type Crosses were made between two plants of Discovery and plants representing five varieties, the genotypic constitutions of which are now known Both plants, D–1 and D–2, proved to be heterozygous for all factors for depth and fasciation

XVIII Discovery, *AaBbFfEe* × Ponderosa, *AABBffee*

F_1

Deep, fasciated (12)		Deep, non-fasciated (4)
AABBFfee	*AABBffee*	*AABBFfEe*
AABBffEe	*AABbffee*	*AABbFfEe*
AABbffEe	*AaBBffee*	*AaBBFfEe*
AaBBffEe	*AaBbffEe*	*AaBbFfEe*
AABbFfee	*AaBbFfee*	
AaBBFfee	*AaBbffee*	

F_1 ratio = 3 deep, fasciated 1 deep, non-fasciated

All F_1 individuals produce deep fruits The ratio should be then 3 fasciated 1 non-fasciated Twenty-seven plants were grown, 17 of which bore fasciated fruits and 10 non-fasciated fruits The ratio is 2 52 1 48 and the deviation 2 14 times the error

A paradox of considerable interest obtains in this cross In F_1 there is a ratio of 3 fasciated 1 non-fasciated, in the F_2 a ratio of 9 non-fasciated 7 fasciated The former ratio is, of course, never possible in F_2 but the illustration shows how very puzzling are some of the phenomena observed in crosses with heterozygous strains

A single plant of the F_1 which produced deep, non-fasciated fruits was selected for self-pollination That the genotypic constitution of this plant was *AABBFfEe* is certain No plants were found in the F_2 which produced shallow fruits as would have been expected had the genotypic formula of the F_1 individual been *AABbFfEe*, *AaBBFfEe* or *AaBbFfEe* The observed F_2 ratio was 67 deep, non-fasciated 32 deep, fasciated, or 10 83 5 17 The deviation from the expected 9 7 ratio is 3 40 times the probable error

XIX Discovery, *AaBbFfEe* × Bolgiano, *aabbffEE*

Deep, non-fasciated (2)		Deep, fasciated (2)	
AaBbFfEE		*AaBbffEE*	
AaBbFfEe		*AaBbffEe*	
Shallow, non-fasciated (6)		Shallow, fasciated (6)	
AabbFfEE	*aaBbFfEe*	*AabbffEE*	*aaBbffEe*
AabbFfEe	*aabbFfEE*	*AabbffEe*	*aabbffEE*
aaBbFfEE	*aabbFfEe*	*aaBbffEE*	*aabbffEe*

F_1 plants were classified as to fasciation but not as to depth of fruit Of 13 plants 5 bore non-fasciated, and 8 bore fasciated fruits The ratio is 77 1 23, a deviation of 0 23 from the theoretical 1 1 ratio The frequencies are too few for any theoretical reasoning, but it is significant that among 13 plants the ob-

served ratio should agree so closely with the theoretical expectation The fruits of the F_1 individual selected for pollination were fasciated The comparative depth of these fruits is not known since the plant was grown in the greenhouse and but two fruits allowed to develop

The segregation in F_2 points to the conclusion that the genotypic constitution of the F_1 plant was *AaBbffEE* The segregation expected from such an individual is 9 deep, fasciated 7 shallow, fasciated Of the F_2 plants, 44 produced deep, fasciated fruits, 53 bearing shallow, fasciated fruits The deviation is 3 20 times the error This deviation is too large, but attention is again called to the fact that it is always difficult to classify as to depth among fasciated fruits without actually measuring the vertical diameters

It is difficult to resist the temptation to digress for a moment at this point, in order to comment upon the reaction of certain commercial breeders to the observation of situations such as obtain in this particular cross The variety Discovery, if indeed it may be termed a variety, is supposed to bear deep, non-fasciated fruits Such fruits are of the Globe type and very desirable A plant is selected by the breeder which bears the fruit desired Among the progeny of this plant are plants producing deep and shallow fruits, fasciated and non-fasciated fruits The selection process is carried further with the same result year after year and the conclusion is reached that it is impossible to "fix" the type Discovery is now crossed with Bolgiano, an early, shallow-fruited variety The F_1 includes large and small Globes, fruits like those of the parent Bolgiano and a new type, the deep, fasciated fruits of Ponderosa Thus are new varieties "produced" The list of named varieties of tomatoes is a long one

A single glance at the genotypes in F_1, Discovery × Bolgiano, in which the Discovery individual was heterozygous for all factors will reveal the fact that none of the F_1 plants will breed true for the Globe type, nor Ponderosa type, but that all of the Bolgiano-like plants will forever breed true for the shallow, fasciated characters

XX Discovery, *AaBbFfEe* × Earliana, *aabbffEE*

F_1, as in the cross Discovery × Bolgiano

The present cross is identical in every way with the cross Discovery × Bolgiano and needs no discussion except as to the F_2 segregation In the F_1, 15 plants produced non-fasciated fruits, 14 plants fasciated fruits, a ratio of 1 03 97, which deviates from the expected 1 1 ratio by only 03 This deviation is 0 27 times the error and is insignificant (See Table V)

In the F_2 a new situation arises Instead of the 9 deep, fasciated 7 shallow, fasciated, of the cross Discovery × Bolgiano, the ratio is 3 shallow, non-fasciated 1 shallow, fasciated The observed frequencies are 63 34, a ratio of 2 60 1 40 Only an F_1 individual of the genotypic constitution *aabbFfEE* could have produced such a ratio (See Table III)

XXI Discovery, *AaBbFfEe* × June Pink, *aaBBffee*

F_1

Deep, non-fasciated (2)
AaBBFfEe
AaBbFfEe

Deep, fasciated (6)
AaBBFfee *AaBbffEe*
AaBbffEe *AaBbFfee*
AaBBffee *AaBbffee*

Shallow, non-fasciated (2)
aaBBFfEe
aaBbFfEe

Shallow, fasciated (6)
aaBBffEe *aaBbFfee*
aaBbFfee *aaBBffee*
aaBbffEe *aaBbffee*

Again, the F_1 segregation was recorded as to fasciation alone The formulae above indicate an expected ratio of 1 non-fasciated 3 fasciated The observed frequencies are 15 35, a ratio of 1 20 2 80 The deviation is 2 21 times the error and is insignificant

In F_2 with the same classification a ratio of 9 non-fasciated 7 fasciated was approached The frequencies are 46 51, a ratio of 7 59 8 41 The deviation is 2 60 times the error

The classification made in this pedigree renders it possible that a few of the plants recorded as bearing non-fasciated fruits may have been included among those recorded as fasciated The

ratio is sufficiently near 9 7, however, to warrant the assumption of *AaBBFfEe* as the genotypic constitution of the F_1 self-fertilized individual Fruits from this plant were deep, non-fasciated Record is made of the fact that the depth of fruit varies from plant to plant, although no accurate classification of plants as to depth of fruit was attempted An F_1 individual of the formula *aaBBFfEe* or *aaBbFfEe* would have produced plants segregating 9 7 for fasciation, but with shallow fruits

APPLICATION OF HYPOTHESIS TO DATA OF PREVIOUS WRITERS

Price and Drinkard (1908, p 30) give the ratio obtained in the F_2 generations from a cross between a variety with roundish-conic fruits and one with roundish-compressed fruits The ratio is 35 conic 13 compressed or 2 92 0 08, a very close fit to a 3 1 ratio The difference (0 08) is but 0 49 times the probable error (0 17) and is insignificant

This is the only record which has come to the writer's attention of a segregation between the characters discussed in the present paper The explanation is quite simple. It is only necessary to assume that the two individuals crossed by Price and Drinkard were of the formulae *AABBFFEE* (deep, non-fasciated) and *aaBBFFEE* (shallow, non-fasciated) The F_1 genotype would thus be *AaBBFFEE* (deep, non-fasciated) The F_2 generation would split into 3 deep, non-fasciated (roundish, conic) 1 shallow, non-fasciated (roundish, compressed) The authors do not mention fasciation With all of the facts in hand the genotypes might prove to be different from those suggested It is not necessary, however, to go beyond the suggested hypothesis for an explanation of the behavior observed by Price and Drinkard in the foregoing cross

SUMMARY OF 9 7 RATIOS

The proof of a complementary factor hypothesis must be sought in the familiar 9 7 Mendelian ratio Collected in Table VI are all of the 9 7 ratios which have been observed in these crosses. Such a segregation for depth is from the genotype

AaBb and for fasciation from the genotype *FfEe* These genotypes are the same, of course, regardless of their origin The summation of all segregations for depth and of all segregations for fasciation eliminates the errors of the small sample The result is a ratio of 9 23 6 77 for depth among 603 individuals and a ratio of 9 30 6 70 for fasciation among 854 individuals In each instance the deviation is approximately equal to the error In the light of such results the writer hesitates not at all in suggesting a complementary factor hypothesis for both depth and fasciation

Summary and Conclusions

1 Crosses have been made among ten varieties of the garden tomato, eight of which produce different types of fruit

2 Each fruit type is produced as a result of a particular combination of depth and fasciation factors

3 The complementary factors *A* and *B* determine the depth of the fruits Genotypes having *A* in the presence of *B* produce deep fruits Those having *A* or *B* in a homozygous condition produce fruits, but slightly deeper than the shallow fruits produced by genotypes with the factors *a* and *b*

4 The complementary factors *F* and *E* inhibit fasciation Genotypes having *F* in the presence of *E* produce non-fasciated fruits Slightly fasciated fruits which may be considered to be teratological are produced in rare instances by such genotypes Genotypes having either *F* or *E* (but not both) in the homozygous condition produce fruits in which fasciation is inhibited only to a slight degree The normal allelomorphs (*f* and *e*) of the factors *F* and *E* determine the production of fasciated fruits

5 A critical examination of the data upon twenty-one crosses made by the writer and one cross reported by Price and Drinkard, in which the F_2 behavior as to fruit type has been recorded, fails to bring to light a single instance in which the depth-fasciation hypothesis is incapable of accounting for the observed phenomena.

6 It has been possible to explain many curious phenomena observed in the tomato cultures by the use of the working hy-

pothesis suggested Such phenomena as the appearance of a Ponderosa type among the F_2 progeny of a cross between two varieties (Imperial and Bolgiano) which bear smaller fruits, the appearance of deep, non-fasciated (Globe type) fruits in the F_2 generation of crosses between varieties which bear fasciated fruits (Imperial × Bolgiano), the appearance of tiny non-fasciated fruits among the F_2 plants from a cross between two varieties (Dwarf Stone and Bolgiano) which bear larger fruits, all of these require the assumption of complementary factors for their explanation

7 The factors here identified have explained certain phenomena which otherwise must have been explained by a hybrid vigor hypothesis Certain crosses produce F_1 plants with larger fruits than those of the parents (e g , Earliana × June Pink), but in many more crosses (e g , June Pink × Ponderosa) the F_1 fruits are smaller Quantitative data to prove these points are to be presented in another paper, but let it be noted here that these results are to be expected from the depth-fasciation hypothesis and need no further explanation

8 Measurements of the depth, width, weight and stem depression of many fruits in these cultures have been made In each of the six crosses which have been investigated in this manner the quantitative data confirm the present hypothesis These data will be published soon

College of William and Mary
Williamsburg, Virginia

TABLE I

MENDELIAN CHARACTERS IN THE GARDEN TOMATO
(from Jones, *American Naturalist*, LI 618)

	Dominant	Recessive
Fruit shape	1 Spherical (non-constricted)	Pyriform (constricted)
Fruit shape	2 Roundish conic	Roundish compressed
Loculation of ovary	3 Bilocular	Plurilocular
Endocarp color	4 Red	Yellow
Epicarp color	5 Yellow	Colorless
Fruit surface	6 Smooth	Pubescent
Vine habit and leaf surface	7 {Standard / Smooth	{Dwarf / Rugose
Leaf margin	8 Serrate (normal or fine leaf)	Entire ("potato" or coarse leaf)
Leaf type	9 *Pimpinellifolium* type	*Esculentum* type
Foliage color	10 Green	Yellow
Inflorescence type	11 Simple	Compound

TABLE II

PEDIGREE LIST OF ALL PARENTS AND CROSSES WITH THE NUMBER OF MATURE PLANTS RECORDED AMONG THE PROGENY

Varieties are designated in the pedigrees as follows B, Bolgiano, JP, June Pink, P, Ponderosa, E, Earliana, I, Imperial, JB, John Baer, D, Discovery, ED, Early Detroit, DC, Dwarf Champion, DS, Dwarf Stone

PARENT STRAINS

Pedigree	Progeny	Pedigree	Progeny	Pedigree	Progeny
B	11	E-3	11	ED	22
B-6	48	E-1	20	ED-2	12
B-7	26	E-3-4-2	50	ED-2-7 op-1	91
B-9	25	E-1-16-2	49		
				DC	20
JP-1	19	I	18	DC-1	25
JP-1-10-2	99	I-5	75	DC-1-1	25
				DC-15-1	25
P-1	9	JB	19		
P-3	19	JB-1-1	98	DS	19
P-3-1	50			DS-5	80
P-3-1-2	50	D	23		
		D-1-1	71		

TABLE II — *Continued*

CROSSES

Cross No	Generation	No of Progeny	Pedigree
I	F_1	50	JP-1-10 × B-6
	F_2	51	(B-6 × JP-1-1)-1
		50	(JP-1-10 × B-6)-1
II	F_1	50	B-7 × E-3-4
		50	E-3-4 × B-7
	F_2	75	(B-7 × E-3-4)-1
		74	(E-3-4 × B-7)-1
III	F_1	41	E-1 × JP-1
		13	JP-2 × E-1
	F_2	100	(E-1 × JP-1)-26
		31	(JP-2 × E-1)-1
		100	(JP-2 × E-1)-10
IV	F_1	38	B-6 × DC-15
		8	DC-15 × B-6
	F_2	76	(B-6 × DC-15)-1
		75	(DC-15 × B-6)-1
V	F_1	55	JP-1-10 × DC-1
		9	DC-1 × JP-1-10
	F_2	74	(JP-1-10 × DC-1)-1
		74	(DC-1 × JP-1-10)-1
		124	(DC-1 × JP-1-10)-1 × JP-1-10-2
		124	DC-1-1 × (DC-1 × JP-1-10)-2
VI	F_1	8	JB-1 × P-3-1
	F_2	50	(JB-1 × P-3-1)-1
		49	(JB-1 × P-3-1)-2
		100	P-3-1-1 × (JB-1 × P-3-1)-1
		10	(JB-1 × P-3-1)-2 × P-3-1-1
		97	JB-1-1 × (JB-1 × P-3-1)-1
		89	(JB-1 × P-3-1)-1 × JB-1-2
VII	F_1	71	JP-1 × P-1
		24	P-1 × JP-1
	F_2	63	(JP × P)-2
		18	(JP × P)-6
		51	(JP-1 × P-1)-18
	F_3	51	(JP × P)-6-15
		52	(JP × P)-2-9
		20	(JP × P)-2-11
		35	JP-1-10 × (JP-1 × P-1)-18
		58	(JP-1 × P-1)-18 × JP-1-10
		51	JP-3 × (JP × P)-10
		45	(JP × P)-10 × JP-3
		151	JP-1 × (JP × P)-7

TABLE II — *Concluded*

CROSSES

Cross No	Generation	No of Progeny	Pedigree
		96	(JP × P)–7 × JP–1
		74	P–3 × (JP × P)–6
		55	(JP–1 × P–1)–18 × P–1–2
VIII	F_1	2	DS–5 × B–6
	F_2	87	(DS–5 × B–6)–2
IX	F_1	3	P × ED (Greenhouse)
	F_2	90	(P × ED)–1
		74	(P × ED)–2
		19	(ED × P)–1 × (ED × P)–2
X	F_1	45	B–6 × P–3–1
		75	P–3–1 × B–6
	F_2	50	(B–6 × P–3–1)–1
		51	(B–6 × P–3–1)–2
		98	(P–3–1 × B–6)–1
XI	F_1	53	ED–2 × JP–1
	F_2	98	(ED–2 × JP–1)–3
		34	(ED–2 × JP–1)–16
XII	F_1	45	ED–2–7 × B–5
	F_2	95	(ED–2–7 × B–5)–1
XIII	F_1	17	DS–3 × JB–13
		45	JB–13 × DS–3
	F_2	63	(DS–3 × JB–13)–1
		75	(JB–13 × DS–3)–1
XIV	F_1	25	DC–1 × ED–2–12
XV	F_1	75	B–6 × JB–13
		6	JB–13 × B–6
	F_2	75	(B–6 × JB–13)–1
		73	(JB–13 × B–6)–2
XVI	F_1	27	P–3–1 × DS–3
	F_2	73	(P–3–1 × DS–3)–2
XVII	F_1	50	I–5 × B–7
	F_2	98	(I–5 × B–7)–2
XVIII	F_1	27	P–3–1 × D–1
	F_2	99	(P–3–1 × D–1)–1
XIX	F_1	3	B–6 × D–1
		10	D–1 × B–6
	F_2	97	(D–1 × B–6)–1
XX	F_1	29	D–1 × E–3–8
	F_2	97	(D–1 × E–3–8)–1
XXI	F_1	50	JP–1–10 × D–2
	F_2	99	(JP–1–10 × D–2)–1

TABLE III

POSSIBLE GENOTYPES AND THE PHENOTYPIC CONSTITUTION OF THEIR PROGENIES

A in the presence of *B* = Deep Fruit, *F* in the presence of *E* = Non-fasciated Fruit

GROUP	GENOTYPIC FORMULAE	CHARACTER OF PROGENY
1	*AABBFFEE*	All deep, non-fasciated
2	*AABBFFee* *AABBffEE* *AABBffee* *AABBFfee* *AABBffEe*	All deep, fasciated
3	*AAbbFFEE* *aaBBFFEE* *aabbFFEE* *AabbFFEE* *aaBbFFEE*	All shallow, non-fasciated
4	*AAbbffee* *aaBBffee* *aabbFFee* *aabbffEE* *AAbbFFee* *AAbbffEE* *aaBBFFee* *aaBBffEE* *aabbffee* *Aabbffee* *aaBbffee* *aabbFfee* *aabbffEe* *AAbbFfee* *AAbbffEe* *aaBBFfee* *aaBBffEe* *AabbFFee* *aaBbFFee* *AabbffEE* *aaBbffEE* *AabbFfee* *AabbffEe* *aaBbFfee* *aaBbffEe*	All shallow, fasciated
5	*AABbFFee* *AABbffEE* *AABbffee* *AaBBFFee* *AaBBffEE* *AaBBffee* *AABbFfee* *AABbffEe* *AaBBffEe* *AaBBFfee*	3 deep, fasc 1 shallow, fasc
6	*AABBFFEe* *AABBFfEE*	3 deep, non-f 1 deep, fasc
7	*AABbFFEE* *AaBBFFEE*	3 deep, non-f 1 shallow, non-f
8	*AAbbFFEe* *AAbbFfEE* *aaBBFFEe* *aaBBFfEE* *aabbFFEe* *aabbFfEE* *AabbFFEe* *AabbFfEE* *aaBbFFEe* *aaBbFfEE*	3 shallow, non-f 1 shallow, fasc
9	*AABBFfEe*	9 deep, non-f 7 deep, fasc
10	*AaBbFFee* *AaBbffEE* *AaBbffee* *AaBbFfee* *AaBbffEe*	9 deep, fasc 7 shallow, fasc
11	*AAbbFfEe* *aaBBFfEe* *aabbFfEe* *AabbFfEe* *aaBbFfEe*	9 shallow, non-f 7 shallow, fasc
12	*AaBbFFEE*	9 deep, non-f 7 shallow, non-f
13	*AABbFFEe* *AABbFfEE* *AaBBFFEe* *AaBBFfEE*	9 deep, non-f 3 deep, fasc 3 shallow, non-f 1 shallow, fasc
14	*AABbFfEe* *AaBBFfEe*	27 deep, non-f 21 deep, fasc 9 shallow, non-f 7 shallow, fasc
15	*AaBbFFEe* *AaBbFfEE*	27 deep, non-f 21 shallow, non-f 9 deep, fasc 7 shallow, fasc
16	*AaBbFfEe*	81 deep, non-f 63 shallow, non-f 63 deep, fasc 49 shallow, fasc

TABLE IV

GENOTYPES INVESTIGATED WITH THE PHENOTYPIC CONSTITUTION OF THEIR PROGENIES

D = Deep, S = Shallow, F = Fasciated, N = Non-fasciated

Group	Genotypic Formula	Pheno-type	No Pl	Ped.	Gen	Number of Plants in Progeny								Total
						D–F	D–N	S–F	S–N	D	S	F	N	
1	*AABBFFEE*	D–N	125	ED	P_1									
2	*AABBFFee*	D–F	117	JB	P_1									
•	*AABBFFee*	D–F	93	I	P_1									
	AABBffee	D–F	128	P	P_1									
	AABBFfee	D–F	8	JB × P	F_1	99				99		99		99
3	*aabbFFEE*	S–N	99	DS	P_1									
4	*aaBBffee*	S–F	118	JP	P_1									
	aabbffEE	S–F	130	E	P_1									
	aabbffEE	S–F	110	B	P									
	aabbffEE	S–F	100	B × E	F_1			149			149	149		149
	aabbffee	S–F	95	DC	P_1									
	aaBbffEe	S–F	50	B × JP	F_1			101			101	101		101
	aaBbffEe	S–F	54	E × JP	F_1			231			231	231		231
	aabbffEe	S–F	46	B × DC	F_1			151			151	151		151
	aaBbffee	S–F	64	JP × DC	F_1			148			148	148		148
5	*AaBBffee*	D–F	95	JP × P	F_1	26		6		26	6	32		32
				JP × P	F_1							132		132
8	*aabbFfEE*	S–N	2	B × DS	F_1			29	58		87	29	58	87

TABLE IV — *Continued*

	aabbFfEE	S-N	1	D × E	F_1		63	34		63	34	34	63	97
9	*AABBFfEe*	D-N	3	P × ED	F_1	71	112			183		71	112	183
	AABBFfEe	D-N	1	P × D	F_1	32	67			99		32	67	99
10	*AaBbffEe*	D-F	120	B × P	F_1	129		70		129	70	199		199
	AaBbffEE	D-F	1	D × B	F_1	44		53		44	53	97		97
14	*AaBBFfEe*	D-N	53	ED × JP	F_1							69	63	132
	AaBBFfEe	D-N	1	D × JP	F_1							51	46	97
15	*AaBbFfEE*	D-N	45	B × ED	F_1	18		16				34	61	95
	AaBbFFEe	D-N	62	JB × DS	F_1					72	66			138
16	*AaBbFfEe*	D-N	1	D	P_1	19	25			44	27	19	25	71
	AaBbFfEe	D-N	81	B × JB	F_1							52	96	148
	AaBbFfEe	D-N	27	P × DS	F_1	22		8		22	8	30	43	73
	AaBbFfEe	D-N	50	I × B	F_1	25	34	17	22	59	39	42	56	98

CROSSES BETWEEN HOMOZYGOTES AND HETEROZYGOTES

Group	Heterozygote	Homozygote	Pedigree	D-F	D-N	S-F	S-N	D	S	F	N
2	*AABBFfee*	*AABBffee*	(JB × P) × P	110			110		110		110
	AABBFfee	*AABBFFee*	(JB × P) × JB	186			186		186		186
4	*aaBbffee*	*aaBBffee*	(DC × JP) × JP			124		124	124		124
	aaBbffee	*aaBBFFee*	(DC × JP) × DC			124		124	124		124
5	*AaBBffee*	*aaBBffee*	(JP × P) × JP	142		123	142	123	265		265
	AaBBffee	*AABBffee*	(JP × P) × P	129			129		129		129
16	*AaBbFfEe*	*aabbffEE*	D × B						8	5	13
	AaBbFfEe	*aabbffEE*	D × E		15	14	15	14	14	15	29
	AaBbFfEe	*AABBffee*	D × P	10	17		27		10	17	27
		aaBBffee	D × JP						35	15	50

TABLE V

TESTS FOR GOODNESS OF FIT OF MENDELIAN RATIOS FOR DEPTH AND FASCIATION OF FRUIT OBSERVED IN THE F_1, F_2 GENERATIONS AND IN THE BACK-CROSSES

Group in Text	Cross and Generation	Observed Frequency	Observed Ratio	Theoretical Ratio	Deviation	Probable Error	Dev /P E
VI	F_2–P × JB	75 Less Fasc	3 03	3			
		24 More Fasc	0 97	1	0 03	0 12	0 26
	P × (JB × P)	61 More Fasc	1 11	1			
		49 Less Fasc	0 89	1	0 11	0 06	1 70
VII	F_2–JP × P	26 Deep Fasc	3 25	3			
		6 Shallow Fasc	0 75	1	0 25	0 65	0 38
	JP × (JP × P)	142 Deep Fasc	1 07	1			
		123 Shallow Fasc	0 93	1	0 07	0 04	1 74
VIII	F_2–B × DS	58 Shallow Non-F	2 67	3			
		29 Shallow Fasc	1 33	1	0 33	0 13	2 66
IX	F_2–P × ED	112 Deep Non-F	9 79	9			
		71 Deep Fasc	6 21	7	0 79	0 40	2 00
X	F_2–B × P	120 Deep Fasc	10 37	9			
		70 Shallow Fasc	5 63	7	1 37	0 38	3 62
XI	F_2–ED × JP	63 Non-F	7 64	9			
		69 Fasc	8 36	7	1 36	0 47	2 93
XII	F_2–B × ED	61 Non-F	2 57	3			
		34 Fasc	1 43	1	0 43	0 12	3 60
		61 Non-F	41 10	48	6 91	1 92	3 60
		18 Deep Fasc	12 13	9	3 13	1 54	2 03
		16 Shallow Fasc	10 78	7	3 78	1 38	2 73
XIII	F_2–JB × DS	72 Deep	8 35	9			
		66 Shallow	7 65	7	0 65	0 31	2 12
XV	F_2–B × JB	96 Non-F	10 49	9			
		52 Fasc	5 51	7	1 49	0 44	3 39
XVI	F_2–P × DS	43 Non-F	9 43	9			
		30 Fasc	6 58	7	0 43	0 63	0 68
		43 Non-F	150 80	144	6 80	10 03	0 68
		22 Deep Fasc	77 15	63	14 15	8 70	1 63
		8 Shallow Fasc	28 06	49	20 95	7 95	2 64
XVII	F_2–I × B	34 Deep Non-F	88 82	81	7 82	8 11	0 96
		22 Shallow Non-F	57 47	63	5 53	7 51	0 74
		25 Deep Fasc	65 31	63	2 31	7 51	0 31
		17 Shallow Fasc	44 41	49	4 59	6 86	0 67
XVIII	F_1–D × P	17 Deep Non-F	2 52	3			
		10 Deep Fasc	1 48	1	0 48	0 23	2 14
	F_2–D × P	67 Deep Non-F	10 83	9			
		32 Deep Fasc	5 17	7	1 83	0 54	3 40

TABLE V — *Concluded*

Group in Text	Cross and Generation	Observed Frequency	Observed Ratio	Theoretical Ratio	Deviation	Probable Error	Dev /P E
XIX	F_1–D × B	5 Non-F	0 77	1			
		8 Fasc	1 23	1	0 23	0 19	1 24
	F_2–D × B	44 Deep Fasc	7 26	9			
		53 Shallow Fasc	8 74	7	1 74	0 54	3 20
XX	F_1–D × E	15 Deep Non-F	1 03	1			
		14 Shallow Fasc	0 97	1	0 03	0 13	0 27
	F_2–D × E	63 Shallow Non-F	2 60	3	0 40	0 12	3 38
		34 Shallow Fasc	1 40	1			
XXI	F_1–D × JP	35 Fasc	2 80	3			
		15 Non-F	1 20	1	0 20	0 17	2 21
	F_2–D × JP	46 Non-F	7 59	9			
		51 Fasc	8 41	7	1 41	0 54	2 60

TABLE VI

SUMMARY OF 9 7 RATIOS FOR DEPTH AND FASCIATION

Cross No	Cross	Number of Plants with		Number of Plants with	
		Deep Fruits	Shallow Fruits	Non-fasciated Fruits	Fasciated Fruits
	D × Self	44	27	25	19
IX	P × ED			112	71
X	B × P	129	70		
XI	ED × JP			63	69
XIII	DS × JB	72	66		
XV	B × JB			96	52
XVI	P × DS			43	30
XVII	I × B	59	39	56	42
XVIII	P × D			67	32
XIX	B × D	44	53		
XXI	JP × D			46	51
Total No of Plants		348	255/603	508	366/874
Observed Ratio		9 23	6 77	9 30	6 70
Theoretical Ratio		9 00	7 00	9 00	7 00
Deviation		0 23		0 30	
Probable Error		0 22		0 18	
Dev /P E.		1 05		1 67	

LITERATURE CITED

CASTLE, W E 1921 An Improved Method of Estimating the Number of Genetic Factors Concerned in Cases of Blending Inheritance Science, N S, 54 223

CRANE, M B 1915 Heredity of Types of Inflorescence and Fruits in Tomato Journ Gen, 5 1–11

EMERSON, R. A 1917 Multiple Factors vs "Golden Mean" in Size Inheritance Science, N S, 40 57–58

Groth, B H A. 1912 The F_1 Heredity of Size, Shape and Number in Tomato Fruits New Jersey Agr Exp Sta, Bull 242

—— 1915 Some Results in Size Inheritance New Jersey Agr Exp Sta, Bull 278

HALSTED, BYRON D 1905 Report of the Botanist New Jersey Agr Exp Sta, pp 423–525

HAYES, H K, AND JONES, D F 1917 The Effects of Cross and Self-fertilization in Tomatoes 1916 Conn Agr Exp Sta Rept

JONES, D F 1917 Linkage in Lycopersicum Am Nat, 51 608–621

PEARSON, K 1914 Tables for Statisticians and Biometricians Cambridge University Press

PRICE, H L, AND DRINKARD, JR, A W 1908 Inheritance in Tomato Hybrids Virginia Agr Exp Sta, Bull 177 18–53

THE PERFECT STAGE OF THE VALSACEAE IN CULTURE AND THE HYPOTHESIS OF SEXUAL STRAINS IN THIS GROUP *

LEWIS E WEHMEYER

THE whole question of perithecial formation in the higher ascomycetes is as yet in a highly unsettled condition The question arises as to whether the factors to be considered are factors of nutrition, growth and environmental conditions, or whether they are in the nature of sexual phenomena, or both The evidence so far is meager and scattered In the course of culturing a number of stromatic Pyrenomycetes, the perithecial stage was obtained from single spore cultures in three cases This proof that, in these species at least, a single asco-spore possesses the potentialities of perithecial formation has led to the following consideration of this question from the cultural evidence at present available Before taking up this discussion, the life-histories of the three species mentioned, *Valsa Kunzei* Fr , *Diaporthe albo-velata* (Schw) Sacc and *Diaporthe binoculata* (Ell) Sacc , will be given below [1]

VALSA KUNZEI FR

Specimens of the perithecial stromata of *Valsa Kunzei* Fr (Fig 1) were collected on twigs of *Thuja plicata* Don near Copeland, Idaho, in August, 1922 The stromata on Thuja twigs are

* Paper from the Department of Botany of the University of Michigan, No 212

[1] Since this paper was written, perithecia with mature asci and ascospores have been obtained from single spore cultures of *Diaporthe galericulata* (Tul.) Sacc , and perithecial initials with "Woronin hyphae" have been found in developing perithecial stromata in single spore cultures of *Diatrype stigma* (Hoffm) de Not and *Eutypella fraxinicola* (Cke. & Pk) Sacc.

rather widely scattered They are pustulate, elliptical to fusoid, and measure 8–1 5 × 7–1 mm They are surmounted by a small, greyish, circular to fusoid disc containing many minute, black, disc-like ostioles The perithecia are numerous, flattened-oval in shape, and measure 260–300 × 200–225 μ The walls are membranous, and the necks long and converging The perithecia are buried in a well differentiated stroma, just beneath the periderm, which is usually outlined beneath by a row of periderm cells and an adjacent darkened area The asci (Fig 2) are numerous, clavate, sessile, or short-stipitate, and measure 26–31 × 4–5 μ The spores (Fig 3) are biseriate, hyaline, 1-celled, allantoid, and measure 7–8 × 1 5–2 μ

On March 1, 1923, sprays of ascospores from the twigs mentioned above were made on plates of Leonian's agar The same methods and media were used as have been mentioned in a former paper (28) Twenty-four hours later these spores had swollen greatly and become oval (Fig 4) They measured 8 × 6 μ, and each had thrown out a single germ tube, 2 μ in diameter, from one end of the spore Single germinating spores, and asci in which all of the spores were germinating were isolated from this culture

On six per cent oat agar there was formed a heavy, cottony, superficial, mycelial growth, which later became greyish and matted, while the surface of the agar often became wrinkled

On March 13, a sterilized twig of *Thuja occidentalis* L was inoculated with mycelium from a single ascus culture On April 10, there was noticed on this twig numerous, minute pustules, 1–3 mm in diameter, slightly raising the periderm These were examined on April 30 At that time they were immature, but seemed to be the beginnings of perithecial stromata As the culture had dried out to a great extent, it was moistened with sterile water and set aside On May 9, the culture was again examined, and the fruit bodies were found to be mature perithecial stromata The perithecia formed in culture, on twigs, constituted an abnormal amount of superficial, greyish, mycelial growth on account of the moisture content of the air in the culture tubes The stromata appeared as small erumpent tufts,

3–6 mm in diameter From these tufts there arose 2–4, united, short-cylindrical, black ostioles The perithecia were spherical to ovoid, 230 270 μ in diameter, and with rather thick, light-colored walls Three to six perithecia were clustered together just beneath the slightly pustulate periderm They were imbedded within a stroma, which was increased above to form a stromatic plug, through which the perithecial necks led to the exterior This stroma was composed of a mixture of interwoven, hyaline hyphae, and dark-colored bark cells The asci were broad clavate, and measured 26–30 $\times$ 5-6 μ The spores were biseriate, allantoid, 1-celled, hyaline, and measured 7–8 $\times$ 1 5 2 μ

As these perithecial stromata arose from an ascus culture, inoculations were subsequently made, from both single ascus and single spore cultures, to test for any indications of sexuality These inoculations were made on twigs of *Thuja occidentalis* on May 11, 1923, and were kept in a cold room at 0 3° C until September 15 When they were then examined, both types of these twig cultures showed the perfect stage exclusively

At the same time that the twig cultures mentioned above were made, single ascus and single spore cultures were also made on six per cent oat agar, and kept at the same temperature These were brought to room temperature on September 18 When examined on October 10, these cultures showed only the imperfect stage of the fungus, which was not found on the twig cultures This imperfect stage (Fig 5) belonged to the genus Cytospora There were formed superficial, stromatic cushions, irregularly hemispherical in shape, and 1–4 mm in diameter The stromata were covered with a greyish weft of hyphae, and were composed within of olive-grey hyphae They were seated on the darkened layer of tissue on the surface of the agar, and contained numerous labyrinthiform locules, which opened to the exterior by one or more openings The walls of the locules were more parenchymatous than the rest of the stromatic tissue, and bore a dense hymenium of thin filamentous conidiophores, which in turn bore the hyaline, allantoid pycnospores, which measured 4–6 $\times$ 75–1 μ (Fig. 6)

From the foregoing data it is apparent that, in this species at least, the necessity of two sexual strains for the formation of perithecia is eliminated, since perithecia and ascospores were consistently produced from single spore cultures On the other hand the type of substratum seems to have a definite influence, as perithecia were formed only on twigs, while pycnidia were formed exclusively on agar

DIAPORTHE ALBO-VELATA (Schw) Sacc

Diaporthe albo-velata (Schw) Sacc is found upon the twigs of various species of Rhus and is often parasitic in its habit The connection of an imperfect stage, *Sporocybe Rhois* (B & C) Sacc, with the ascus stage of this fungus was reported in a former paper (28) It was there shown that in both agar and twig cultures, under moist conditions, this fungus forms superficial, irregularly cylindrical stromata, some of which contain masses of elliptical, light-brown spores On Tilia twigs, under dry conditions, there were formed long cylindrical, hair-like, sporodochia, capped by a spherical, black mass of oval, blackish-hyaline, 1-celled spores, measuring 6–9 × 2 5–3 μ Since the occurrence of this Sporocybe stage, several other types of fruit bodies have been obtained in culture

Two cultures of this fungus from single spores, made on six per cent agar on February 10, and March 2, 1923, respectively, were placed in a cold room at 0–3° C on June 5 These two cultures were removed to room temperature on September 18 Upon examination on October 23, there were found near the margin of the cultures, compounded stromatic masses, rather larger than the normal conidial formations These had clusters of long thin cylindrical projections resembling the ostioles of the perithecial stage There were also found small orange-colored spore masses on the surface of these stromata These proved to be masses of 2-celled, hyaline spores, elliptical to fusoid in shape, constricted at the septum, and measuring 16–23 × 2 5–3 5 μ Vertical sections of these stromata showed that they were composed of a brown prosenchymatous tissue They contained two to many

perithecia-like receptacles, with thick, dark-brown, pseudoparenchymatous walls, and more or less well developed necks The interior of these receptacles was filled with a mass of loose, light-brown, mycelial threads, in which the masses of the spores mentioned above were mixed The relation between the spores and the mycelium was difficult to determine, but a number of cases were found where the spores were being formed at the tips of the mycelial hyphae These spores, which resemble strikingly the ascospores, were also occasionally found with the characteristic appendages of the ascospores These, it seems, were formed in the abstriction of the spores, the spore carrying with it an attenuated protoplasmic thread as it was pinched off from the hyphal tip

On May 28, 1923, a sterile twig of *Tilia americana* L was inoculated with mycelium from a single spore culture This twig was then placed at 0–3° C for three months It formed the usual stromatic cushions on the surface of the twig, but some of these threw out several filamentous stalks resembling the sporodochia of the Sporocybe stage Upon examination on November 27, however, the perfect stage was found in these stromata, as well as in others which had not thrown out such filamentous ostioles, as they proved to be In the younger stromata, where these ostioles were not yet formed, a second imperfect stage belonging to the genus Phomopsis, but with only the alpha type of spore present, was found above the developing perithecia

The perithecial stage on Tilia twigs appeared on the surface as brownish, hemispherical, mycelial stromata, from some of which there developed 4–8 long cylindrical ostioles These were 1-2 mm long, with a thread-like apex, and often thickened at the base The spherical perithecia were sunken in the unaltered bark cortex They were 3–400 μ in diameter, and had long slender necks which terminated above in the fascicle of ostioles The asci were clavate, and measured $52–62 \times 10–13$ μ The spores were biseriate, 2-celled, hyaline, fusoid, constricted at the septum, and with a short hyaline appendage at each end They measured $14\ 5–18 \times 4–5$ μ

The Phomopsis stage on Tilia (Fig 7) was formed beneath the

surface stromatic cushions, and above the developing perithecia The spores were developed within a stroma, which developed beneath the periderm, and which it ruptured by its growth The cavity in this stroma was one-chambered, irregular in shape and possessed a differentiated wall composed of closely woven hyphae, with orange-brown walls The cavity wall was surrounded by an indefinite mass of hyphal and host tissues The spores were constricted from the tips of long, cylindrical, hyaline conidiophores They were oval to oblong-fusoid, hyaline one-celled, and light-yellow in mass They measured 5–8 (10) × 2–3 μ

This form is normally found on species of Rhus, and is often apparently parasitic upon that host All three stages of its life-history have been produced saprophytically, however on twigs of *Tilia americana* in culture It can therefore be no more than a weak facultative parasite, and is not limited to species of Rhus, although the writer is not aware of its reported occurrence on any other host in nature We have here also a form showing two distinct types of perfect stages, one a Sporocybe, and the other a Phomopsis There are formed in culture, as shown in a former paper (28), apparently intergrading forms between these two types

Whether the curious formation found on agar, as described above, can be considered as an abortive attempt at ascospore formation, is an open question Klebahn (16) reports sclerotial bodies in the life-histories of *Mycosphaerella hieracii* (Sacc & Briard) Jaap, and *M fragariae*, which he seems to consider as abortive perithecia In *M hieracii* there are sometimes formed bacteria-like spores within these "sclerotia"

DIAPORTHE BINOCULATA (Ellis) Sacc

Perithecial stromata of *Diaporthe binoculata* (Ellis) Sacc were collected on twigs of *Ilex verticellata* (L) Gray near Ypsilanti, Michigan, on March 7, 1923 The stromata are scattered, circular in outline, conical pustulate, and 8–1 2 mm in diameter The disc is dirty black, containing 4–6 large, hemispherical, papillate ostioles The perithecia are spherical, 4–500 μ in diam-

eter, with short, stout necks, and membranous walls, some 13 μ thick The perithecia are buried in an altered, whitened area of the bark cortex, which is bounded by a black dorsal line, which dips to the wood surface, there forming a continuous stratum between bark and wood The asci (Fig 13) are long clavate to cylindrical, and measure 115-130 $\times$ 13 μ The paraphyses are broad filiform, band-like, 5 μ wide, and contain large oily droplets The spores are obliquely uniseriate, broad-ellipsoid, 2-celled, hyaline, and constricted at the septum They measure 15–16 5 $\times$ 7 8 5 μ Each cell of the spore is nearly isodiametric, and contains a large refractive droplet

On April 23, 1923, a suspension of ascospores from the twigs mentioned above was made in sterile distilled water Sprays of this suspension on Leonian's agar showed no germination The twigs were then placed in a damp chamber for three days, and suspensions then made in both distilled water and a weak infusion of Ulmus bark A spray of the water suspension on Leonian's agar gave no germination, but the spores in the Ulmus infusion germinated after twenty hours The germinating spores (Fig 12) did not swell, and threw out one or two germ tubes, 2 μ in diameter On May 10, spore suspensions were again made in distilled water, Ulmus bark infusion, and Ulmus bark infusion plus a sugar solution The water suspension gave only a very few germinating spores A spray of the same on Leonian's agar gave about fifty per cent germination In both of the Ulmus infusion suspensions the germination approached one hundred per cent

On May 27, transfers were made to oat agar tubes, and to twigs of *Tilia americana* L and *Ulmus americana* L These cultures were placed in a cold room at a temperature of 0–3° C They were removed to room temperature on September 18 The agar cultures had formed a superficial growth of tufted reddish-brown mycelium, and numerous whitish to tan, hemispherical, mycelial cushions Upon examination on October 24, there were found, beneath these mycelial masses, black, sclerotia-like bodies imbedded in the agar They were spherical and composed of darkened pseudo-parenchyma, and only occasionally

showed a slight differentiation into an outer, darker wall, and a lighter-colored central mass

A twig of *Tilia americana*, inoculated from a single spore culture, showed pycnidial pustules when removed from the cold room on September 18 These were examined on October 29, when they appeared as open pustules (Fig 10) 5–1 5 mm in diameter The spores were formed in irregular cavities within a stroma composed of dark thick-walled hyphae The cavities had a slightly differentiated wall of smaller and more parenchymatous cells, which were lined within with a hymenium of long cylindrical, hyaline conidiophores, measuring $30–40 \times 1-2\ \mu$ The spores varied in size and shape, being merely the abstricted tips of these conidiophores They were cylindrical to fusoid, or rarely elliptical, 1-celled, hyaline, often somewhat curved, and measured $6–13 \times 1–2\ \mu$ (Fig 11) The stroma pushed back the periderm, and its surface was usually exposed Where rapid growth of this stroma took place, the hymenial layer was often more or less exposed, and the spores were formed in an irregular, exposed cavity Young perithecia were found imbedded beneath these stromata in some instances

A twig of *Ulmus americana* L, inoculated from a single spore culture, showed on November 6 a number of fascicles of ostioles which upon examination proved to be stromata of the perfect stage The stromata appeared as circular or oval pustules, 8–1 8 mm in diameter, and were composed of a fascicle of 5–15 elongated, stout-cylindrical, black ostioles, about 1 mm long, surrounded by the collar of the ruptured periderm The tips of the ostioles were often covered with a greenish-black pubescence The perithecia were spherical or somewhat flattened, 450–500 μ in diameter, and deeply buried in an irregularly polystichous manner Their necks were long and sinuous The stroma was outlined by a narrow, black line which dipped to the wood surface, but the area within the line was not bleached, as was the case on Ilex in nature The asci were clavate to cylindrical, with a flattened tip containing a refractive ring, and an abruptly narrowed base The spores were uniseriate in the ascus, fusoid-elliptical, 2-celled, hyaline, constricted at the septum, 15–18 $\times$

8–10 μ and composed of two isodiametric cells, each with a large central oil drop The tissues of the perithecial walls and necks were of a greenish-black tint

Pycnidia were also found on Ulmus, but differed somewhat from those found on Tilia The cavities were found buried in a lighter-colored stroma just above the forming perithecia (Fig 8) This stroma formed the disc through which the ostioles penetrated The spores here were more filiform, and more strongly curved (Fig 9) They measured 13–16 $\times$ 1–1 5 μ The walls of the cavity were of darker hyphae or often merely an indefinite mixture of host and fungous cells

The two types of spores found on Tilia and Ulmus respectively may be considered as the alpha and beta types of a Phomopsis From the foregoing data we see that this species also has the ability of producing perithecia from a single spore Neither is it limited to Ilex as a host, as it has formed perithecia in culture on both Tilia and Ulmus

DISCUSSION

From the evidence available it seems apparent that whatever the factors of perithecial formation may be, they are both specific and complex Each species must be considered separately Neither must too great emphasis be placed upon any one factor Certain factors may be more or less generally essential, while other factors will undoubtedly be found to vary from species to species Each species must have certain favorable conditions of growth before perithecial formation is possible In addition to these requirements there may be in some species the necessity of the stimulus of the union of two sexual strains

The data as to the physiological factors for perithecial formation is scattered over such a wide variety of forms that only suggestions can be drawn from it It has been the writer's experience, with the stromatic forms, that the conditions most favorable for vegetative growth, or production of imperfect fruit bodies, often do not seem favorable for perithecial formation Most of the culture work with pyrenomycetous fungi seems to

show that the perfect stage is difficult to obtain in culture Furthermore, where perfect stages are obtained artificially they are much more frequently obtained on the natural substratum than on artificial nutrient media Klebahn (16), in his work with a number of species of *Mycosphaerella*, obtained the perfect stage by overwintering infected leaves, or subjecting such leaves to alternate moistening and drying In a few cases he obtained sclerotia-like bodies in agar cultures which he considered undeveloped perithecia, but no mature perithecia were obtained He encountered the same results with *Didymella lycopersici* Kleb (17), and other leaf-inhabiting forms Stone (26) also obtained the perithecia of *Mycosphaerella ontarioensis* Stone, and *M pinodes* (Berk & Blox) Niesl on infected leaves several months after they had been killed by the fungus, but failed to obtain perithecia of the same species in agar cultures The writer has found this especially true with the stromatic forms Out of some twenty to thirty forms, carried both on twig and agar cultures, only four have shown the perfect stage, and all of these have been on twig cultures Only two abortive attempts at the formation of perithecia on agar have been observed On the other hand nearly all of these forms carried in culture have produced the imperfect stage on both agar and twig cultures Incidentally three of the four forms showing the perfect stage have been of the genus *Diaporthe*, and the fourth of the genus *Valsa* It is interesting in this connection to note that in spite of the enormous amount of work done upon the chestnut blight fungus (*Endothia parasitica* (Murr) P J & H W And), there seems to be no report of the perfect stage obtained in culture Graves (10), in his work upon *Melanconis juglandis* (E & E) Graves, similarly failed to obtain the perfect stage in culture

On the other hand there seem to be certain groups which form perithecia comparatively easily in agar cultures Klebahn (16) reports the occurrence of perithecia of a number of species of the genus Gnomonia (*G rosae, G gnomon, G intermedia, G fragariae, G setacea and G melanostyla*) in agar cultures The work of Miss Stoneman (27), Shear and Wood (22), Edgerton (7, 8), and many others on the Anthracnoses has shown

that the perithecia of these forms are obtained with comparative ease in agar cultures It might here be mentioned that the forms here given as producing perithecia in culture (Diaporthe & Valsa) can probably be considered as the most closely related stromatic forms to the foregoing genera (Gnomonia and Glomerella)

What, then, are the conditions which bring about the formation of perithecia in nature, which are absent in culture? There are a number of possibilities, depending probably upon the group to be considered The parasitic forms present a special case There is a likelihood in these cases of chemical relationships in the host which are absent in synthetic media, or which are destroyed by sterilization in the case of sterilized twigs Many pyrenomycetes are, however, only weak parasites, and form their perithecia usually after the host is killed in one way or another The case of *Diaporthe albo-velata,* mentioned above, shows that a form acting as a weak parasite may form perithecia saprophytically

The existence of a chemical stimulus necessary for perithecial formation, over and above that necessary for normal growth and imperfect reproduction, has also been suggested Miss Cayley in 1921 (4) stimulated the formation of the perithecia of *Nectria galligena* Bres by the addition of a one per cent solution of glycerine to certain starchy media The perithecia failed to develop when the glycerine was omitted Leonian in 1921 (18), working with *Valsa leucostoma* (Pers) Fr , found that the addition of NaCl or 2–12% sugar to oatmeal agar stimulated the formation of perithecia On the other hand perithecia formed on corn meal agar without the addition of sugar, the addition of two per cent sugar here inhibited perithecial production He also found that if this perithecial stimulus was absent for the first six days of the growth of the culture, the perithecia would not be formed Rand (21), working with *Mycosphaerella convexula* (Schw) Rand, obtained mature perithecia upon cooked corn meal, corn meal agar, and potato cylinders, while only immature perithecia were obtained on beef agar and oxalic acid agar

Investigators who have worked with the forms mentioned above (Glomerella, etc), which produce perithecia in synthetic cultures seem to oppose this theory of a nutritional stimulus Shear and Wood (22) and Shear (24), in their work upon Glomerella, found that the type of culture media, light, temperature, and moisture were factors which had very little effect upon perithecial production Shear (23) found the same to be true in his work with *Guignardia vaccinii* Shear Harter (12) attempted to bring about the production of asci from pycnospore strains of *Diaporthe batatatis* by the use of various nutrient media, acids, and alkalies, with only negative results The evidence in this group tends to show that certain single spore strains will produce only pycnospores, while other strains will have the ability of producing ascospores

The writer is inclined to believe that the reasons for the failure of perithecial formation in culture are to be sought in other than chemical stimuli There must be available, to be sure, the necessary nutrient substances for growth and reproduction These are probably present however, in both agar and twig culture substrata, since mycelial growth and the formation of the imperfect stage are normal One of the most difficult factors to control in tube cultures is the distribution of moisture Under natural conditions in the field, twigs and branches upon which stromatic forms are growing are either periodically thoroughly saturated by rains, or lie in damp situations where the substratum is continually saturated In either case there is a free play of air currents, which keeps the humidity of the surrounding atmosphere comparatively low In culture tubes or chambers, on the other hand, outside of the original saturation upon sterilization, it is very difficult to get moisture into the twig or agar, while the humidity of the atmosphere is kept comparatively high by evaporation

Correspondingly, there is always an abnormal amount of superficial, mycelial growth in tube cultures, and stromatic formations are abnormally developed on the surface Where perithecia are developed, it is usually under comparatively dry conditions, as on the drier portions of the substratum, or after

the culture has dried out This is not due either to the greater age of these parts, since twigs inoculated on the lower, moister portion of the culture will develop perithecia on the upper, younger, but drier portions It seems that a high atmospheric humidity and lack of circulation lead to a superficial growth of mycelium, and the use of the food-supply in the vegetative growth or the formation of the imperfect stage Leonian (19) in his work on the Sphaeropsidales states that "Mycelial growth and reproduction are parallel within a very wide margin" Perithecial formation apparently depends upon a proper balance of moisture within the substratum, and evaporation from its surface Since the perithecial stromata of these Fungi are formed beneath the periderm within the bark tissues, the moisture relations within the bark may well be of importance for this type of fructification We may be dealing here again with transpiration phenomena, which have been shown by Klebs (14) to be a controlling factor in the reproduction of *Sporodinia grandis* The physical character of the substratum also may have an effect upon perithecial formation The bark tissues of a twig allow free interchange of gases and water vapour, while in agar this is not possible beneath the surface The mycelial growth of these forms is accordingly chiefly upon the surface

Stevens (25), in observing the effect of climatic factors on a large number of artificial infections of *Endothia parasitica,* found that there was a striking correlation between the amount and distribution of rainfall, and perithecial production During dry seasons perithecia were usually entirely absent, while during wet seasons perithecia were produced in abundance, apparently independently of temperature, or the age of the infection Klebahn's success in obtaining perfect stages by alternately moistening and drying infected leaves also points to moisture as an important factor in perithecial productions Matz (20), working with *Botryosphaeria Berengeriana* de Not, found that although this form produced micro- and macro-pycnospores, and ascospores on infected pecan twigs, it remained sterile on various agars and on twig cultures, forming only occasionally

sterile stromata Suspecting that this was due to a high humidity in the cultures, he coated twigs, which had been infected with the fungus, with paraffin to prevent the moist air from coming in contact with the surface of the twigs Although no ascospores were formed on twigs treated in this way, mature stromata containing both micro- and macro-pycnospores were obtained Further investigations of these moisture relations under controlled conditions are highly desirable

Besides the physiological factors considered above, there is always the possibility of the necessity of the union of two independent sexual strains for ascospore production If any species possesses two separate sexual strains the necessity of such a stimulus might account for the absence of perithecia, certainly in single spore cultures Many, however, of the stromatic forms cultured were also carried as single ascus cultures, with no differing results

The matter of sexuality in the ascomycetes has been under discussion for some time and has been approached from the cytological and morphological sides in a number of forms These investigations have resulted in the finding of various degrees of sexuality, as far as the occurrence of fertilization phenomena, and the production of sex organs are concerned In general the higher types of ascomycetes show a further retrogression in the type of sexuality possessed It has been shown by Blackman and Welsford (2), in *Polystigma rubrum* DC , and by Brooks (3), for *Gnomonia erythrostoma* Pers , that the ascogenous hyphae in these forms no longer arise from the cells of the archicarp, which soon degenerate In the Valsaceae we have almost no cytological evidence to judge from Fuisting (9) found coils of hyphae in the young perithecia of Diatrype and Eutypa, which he considered as " Woronin hyphae," and by analogy supposed them to be degenerate sex organs which now probably serve merely as a stimulus to perithecial formation, without necessarily serving a sexual function P J Anderson (1) found that in *Endothia parasitica* the ascogonial cells degenerated, and that there was very little evidence of the formation of ascogenous branches from the ascogonium The origin of the ascogenous hyphae

could not be determined There is at least no morphological evidence in this group of the existence of two separate sexual strains

The cultural evidence is as yet very limited, especially in the stromatic forms The existence of two separate sexual strains necessary for the complete formation of sexual fruit bodies was shown by Dodge (6) to exist in the ascomycetes, in *Ascobolus magnificus* Dodge, in 1920 In 1923, Kirby (13) reported two strains of *Ophiobolus cariceti* which together form perithecia on wheat stems or wheat agar, but fail to do so when cultured alone In 1914, Edgerton (8) reported the occurrence of plus and minus strains in the genus Glomerella The isolation of the sexual strains here however does not seem to be complete The plus strain will form perithecia, in local groups, alone The minus strain produces numerous perithecial initials, but these produce mature asci and spores only under the stimulus of special nutrient media Edgerton suggests that the plus strain is the antheridial strain and produces oogonia occasionally When this occurs the local groups of perithecia are found If on the other hand the minus strain is the oögonial strain, numerous perithecia may be initiated, but because of the lack of antheridia these do not reach maturity The stimulus of a favorable medium may either cause the maturity of these perithecial initials itself, or stimulate the formation of antheridia and thereby bring the asci to maturity as a result of fertilization Where the two strains are grown together, a dense line of perithecia is formed along the line of contact In 1923, Miss Wineland (29), working with mono-spore cultures of *Fusarium moniliforme*, obtained perithecia-like bodies from a certain strain When this strain was cultured with a second strain, which did not form such bodies, mature perithecia of a species of Giberella were obtained

A number of authors have also mentioned a difference in ability to form fruiting bodies between conidiospore and pycnospore strains on the one hand and ascospore strains on the other Klebahn (15), in 1905, found that the mycelium of *Gnomonia veneta* (Sacc & Speg) Kleb , derived from the conidia (*Gloeospo-*

rium nervisiquum (Fck) Sacc), failed to produce perithecia upon sterile leaves of Platanus, while mycelium from ascospores of the same fungus produced perithecia in similar leaf cultures Leonian (18) also mentions this phenomenon in his work with *Valsa leucostoma* Miss Cayley in 1923 (5), in a study of aversion between mono-spore strains of *Diaporthe perniciosa* Marchall, also found that mono-ascospore cultures usually gave numerous perithecia, and only comparatively few pycnidia, while pycnospore cultures gave in general only pycnidia Three pycnospore cultures, one of which was a mono-spore culture, however gave perithecia No indication of sexual strains was obtained In 1912, Harter, and Harter and Field (11, 12), reported two strains of *Diaporthe batatatis*, one of which produced perithecia, while the other did not His re-isolations from the perithecial strain were apparently always made by the isolation of a complete ascus with its germinating spores Whether or not the perithecial strain, therefore, was in reality a combination of two sexual strains necessary for the production of perithecia, cannot be determined What the interpretation of the foregoing phenomena may be, or whether they are related in any way to the pycnospore and ascospore strains of Glomerella and similar forms, must remain unanswered for the present

The cultural evidence for sexual strains in the ascomycetes seems to parallel somewhat the cytological evidence for sexuality, in that there seem to be varying degrees of isolation of these sexual strains In Ascobolus and Ophiobolus, these seem to be sharp and distinct In the Gibberella obtained by Miss Wineland, there seems to be a tendency to form perithecia by one of the strains In the Glomerellas worked on by Edgerton this tendency seems to be further developed, the plus strain here being able to mature some perithecia alone In the other forms as *Diaporthe perniciosa* this separation of strains seems to be complete, some strains forming perithecia and others not Shear (24) believes this to be the case in Glomerella In the stromatic forms there seems to be no evidence as yet for the necessity of the union of two sexual strains for the formation of perithecia Miss Cayley has obtained perithecia of *Diaporthe perniciosa*

from single ascospores and the writer has obtained perithecia from the three forms here described from single ascospores

In conclusion the writer wishes to thank Dr C H Kauffman for his helpful suggestions throughout this study

UNIVERSITY OF MICHIGAN

BIBLIOGRAPHY

1 ANDERSON, P J 1913 The Morphology and Life History of the Chestnut Blight Fungus Penn Chest Blight Comm, Bull No 7

2 BLACKMAN, V H AND WELSFORD, E J 1912 The Development of the Perithecia of Polystigma rubrum Ann Bot, 26 761

3 BROOKS, F T 1910 The Development of Gnomonia erythrostoma Pers Ann Bot, 24 585

4 CAYLEY, DOROTHY M 1921 Some Observations of the Life History of Nectria galligena Bres Ann Bot, 35 79

5 CAYLEY, DOROTHY M 1923 The Phenomenon of Mutual Aversion between Mono-spore Mycelia of the same Fungus (Diaporthe perniciosa Marchall) with a Discussion of Sex Heterothallism in Fungi Journ Genetics, 13 353

6 DODGE, B O 1920 The Life History of Ascobolus magnificus Mycologia, 12 115

7 EDGERTON, C W 1908 The Physiology and Development of Some Anthracnoses Bot Gaz, 45 367

8 EDGERTON, C W 1914 Plus and Minus Strains in the Genus Glomerella Journ Bot, 1 244

9 FUISTING, W 1867 Der Entwickelungsgeschichte der Pyrenomyceten Bot Zeit, 25 177, 185, 193

10 GRAVES, A H 1923 The Melanconis Disease of the Butternut (Juglans cinerea L) Phyt, 13 412

11 HARTER, L L, AND FIELD, ETHEL C 1912 Diaporthe, the Ascogenous Form of Sweet Potato Dry Rot Phyt, 2 121

12 HARTER, L L 1913 A Dry Rot of Sweet Potatoes Caused by Diaporthe batatatis Bur Plant Ind, U S Dep Agr, Bull 281

13 KIRBY, R S 1923 Heterothallism in Ophiobolus cariceti (*abstract*) Phyt, 13 35

14 KLEBS, GEORG 1898 Zur Physiologie der Fortpflanzung einiger Pilze. I Sporodinia grandis Jahr f Wiss Bot, 32 1

15. KLEBAHN, H 1905 Untersuchungen über einige Fungi Imperfecti und die zugehorigen Ascomycetenformen I–II Jahr f Wiss Bot, 41 485

16 KLEBAHN, H 1918. Haupt- und Nebenfruchtformen der Ascomyceten

17 KLEBAHN, H 1921 Der Pilz der Tomatenstengelkrankheit und seine Schlauchfruchtform Zeit f Pflanz, 31 1

18 LEONIAN, L H 1921 Studies on the Valsa Apple Canker in New Mexico Phyt, 11 236

19 LEONIAN, L H 1924 A Study of the Factors Promoting Pycnidial Formation in Some Sphaeropsidales Journ Bot, 11 19

20 MATZ, J 1916 A Method to Induce Sporulation in Cultures of Botryosphaeria Berengeriana. Phyt, 6 387

21 RAND, F V 1911 A Pecan Leaf Blotch Phyt, 1, 133

22 SHEAR, C L AND WOOD, ANNA K 1907 Ascogenous Forms of Gloeosporium and Colletotrichum Bot Gaz, 43, 254

23 SHEAR, C L 1907 Cranberry Diseases Bur Plant Ind, U S Dep Agr, Bull 110

24 SHEAR, C L 1913 Studies of Fungous Parasites Belonging to the Genus Glomerella Bur Plant Ind, U S Dep Agr, Bull 252

25 STEVENS, N E 1917 The Influence of Certain Climatic Factors on the Development of Endothia parasitica (Murr) And Journ Bot, 4 1

26 STONE, R E 1915 Life History of Ascochyta on Some Leguminous Plants II Phyt, 5 4

27 STONEMAN, BERTHA A 1898 A Comparative Study of the Development of Some Anthracnoses Bot Gaz, 26 69

28 WEHMEYER, L E 1923 The Imperfect Stage of Some Higher Pyrenomycetes Obtained in Culture Papers Mich Acad Sci, 3 245

29 WINELAND, GRACE O 1923 The Production in Culture of the Ascigerous Stage of Fusarium moniliforme (*abstract*) Phyt, 13 51

EXPLANATION OF PLATE XIX

FIGS 1–6 *Valsa Kunzei* Fr

FIG 1 Vertical section of perithecial stroma on *Thuja plicata* Don.

FIG 2 Ascus with ascospores

FIG 3 Ascospores

FIG 4 Germinating ascospore

FIG 5 Vertical section of pycnidial stroma on oatmeal agar

FIG 6 Pycnospores

FIG 7 Perithecia-like structures of *Diaporthe albo-velata* (Schw) Sacc. formed in oatmeal agar

FIGS 8–13 *Diaporthe binoculata* (Ellis) Sacc

FIG 8 Type of imperfect fruit body formed on *Ulmus americana* L. above groups of young perithecia

FIG 9 Pycnospores from above type of fruit body on Ulmus

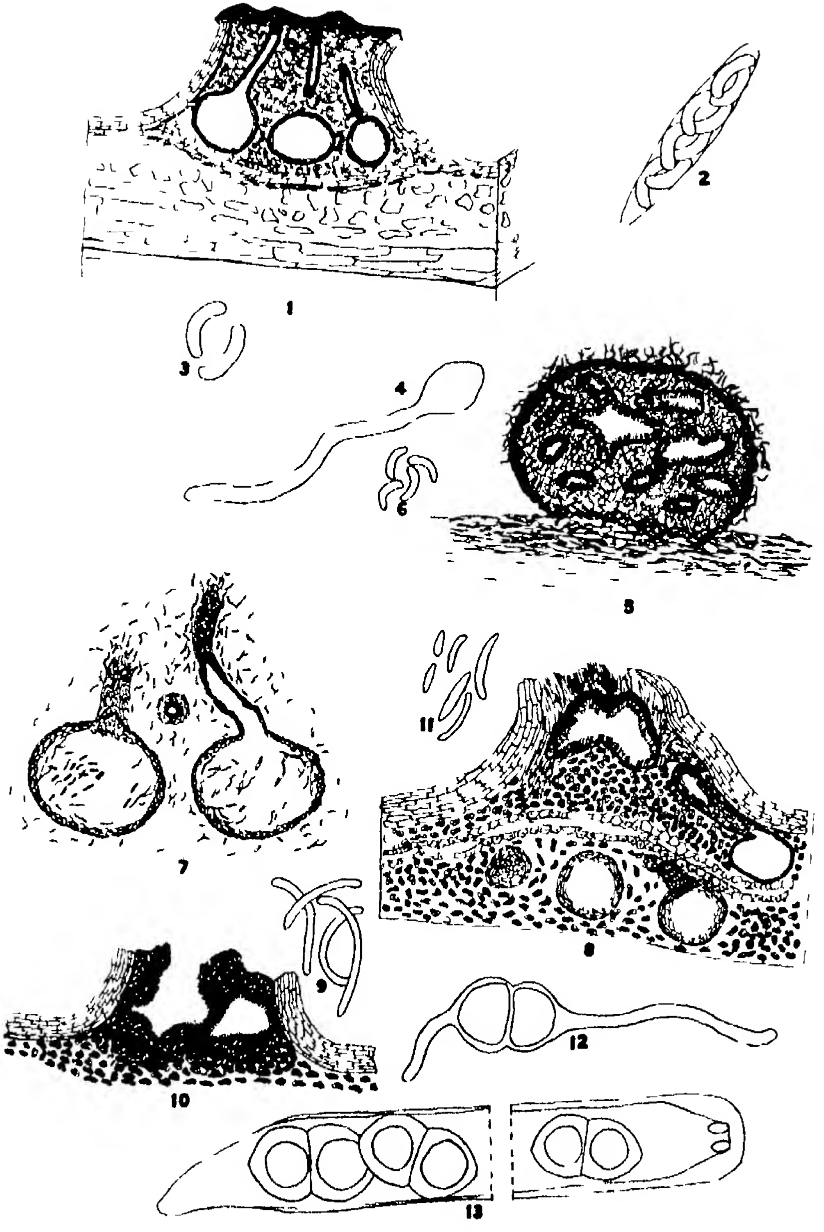
FIG 10 Type of imperfect fruit body found on *Tilia americana* L.

FIG 11 Pycnospores from above fruit body on Tilia.

FIG 12 Germinating ascospore

FIG 13. Ascus with ascospores.

PLATE XIX



OBSERVATIONS ON THE MORPHOLOGY OF THE SEED IN PHYTOLACCA

E F WOODCOCK

THE writer described in an earlier paper (5) the development of the seed in certain Polygonaceae and showed that all the storage material in the seed is endosperm, rather than perisperm and endosperm as suggested by Johnson (3) Associated with the Polygonaceae, Johnson (p 368) mentioned the families Chenopodiaceae, Phytolaccaceae and Caryophyllaceae Johnson was, no doubt, influenced by Harz (2) in his conclusion, since Harz (p 1102) carefully figures and describes the buckwheat seed, considering the entire storage region as perisperm

Heimerl writing on the Phytolaccaceae in Engler and Prantl (1) briefly describes the external appearance of the seed and states that the storage region consists of starchy or fatty perisperm

Harz (p 1089) considers the storage region in the genus Phytolacca as consisting of two parts, i e , a large central perisperm containing only starch, and a small cap-like mass of endosperm fitting over the root end of the embryo, the cells of this endosperm portion containing fat and aleuron but no starch

Johnson (4), working on the Piperaceae, looked upon the very abundant perisperm as the real storage region, it being separated from the embryo by a layer of endosperm, which, instead of acting as a storage region, serves to digest and pass on food material to the embryo from the perisperm In an earlier paper (3, p 368) Johnson had already pointed out this restriction of the endosperm in the genus Saururus, formerly placed in the family Piperaceae, and suggests the probability of a similar relation existing in the family Phytolaccaceae

The fact that the writer did not find the conditions in the

Polygonaceae to be as suggested by Johnson, caused him to make a detailed study of the morphology of the seed of Phytolacca to determine whether the conditions suggested by Johnson were true in a representative species of Phytolaccaceae

DESCRIPTION AND DISCUSSION OF THE MORPHOLOGY OF THE SEED

The species *Phytolacca americana* was used as a source of material Microtome sections stained with Delafield's haematoxylon, supplemented with free-hand sections of the later stages, were used for the interpretation of conditions in the developing seed

The laterally flattened ovules are campylotropous, having a short funiculus with the micropyle turned toward the base (Fig 8) At about the time that the embryo is in the octant stage, it corresponds quite closely with the typical Bursa embryo The suspensor of *P americana*, however, is a short thick structure consisting of only a few irregular cells (Fig 2), whereas, in Bursa, it consists of a filament of seven or eight cylindrical cells The embryo sac at this time is a long, narrow, curved structure, occupying a peripheral position in the nucellus, and is separated from the integuments by a layer of nucellus consisting of four or five rows of irregularly arranged cells (Fig 1) The embryo sac extends about two-thirds of the distance around the ovule and is lined with a layer of cytoplasm in which are imbedded a few endosperm nuclei At this stage of development there is evident a striking difference in the shape of the cells which make up the outer integument The cells in the outer layer of the integument appear in side view pillar-like (Fig 3) and in top view somewhat elongated The cells have large vacuoles in which are brown granules The inner layer of the integument is about the thickness of the outer layer, but consists of several rows of irregularly arranged cells The micropylar portion of the embryo sac is separated from the micropyle by the nucellus (Fig 2), which is five to eight cells in thickness At this stage of seed development there appears no stored material in any of the cells of the nucellus

As development proceeds growth and nuclear division, followed by cell wall formation, occur quite rapidly in the endosperm until at the time the cotyledons of the embryo are as long as the hypocotyl the embryo sac is completely filled with cellular endosperm which surrounds the embryo (Fig 4) The embryo sac has increased in width and length until it extends almost entirely around the peripheral region of the nucellar tissue It is separated from the integument by a layer consisting of only a few compressed cells The endosperm tissue at this time is made up of large, thin-walled, vacuolated parenchyma cells (Fig 5) None of the cells of the endosperm contain stored material in the form of starch or aleuron, in fact, their extremely thin-walled and vacuolated condition would lead one to conclude that they were not destined for storage purposes At this time starch grains begin to appear in that portion of the nucellus surrounded by the embryo The grains are of two sizes and are located near one side of the cell (Fig 6) The large grains, one or two in number, are compound, spherical structures made up of small parts which are about the size of the numerous small, simple, somewhat spherical grains

The micropylar portion of the young seed, in a slightly later stage of development, is shown in Fig 7 The plumule is evident as a rounded outgrowth at the base of the cotyledons In this, as well as in the previous stage, the cotyledons are semicircular in cross-section with their flat surfaces in contact and placed at right angles to the flat surface of the seed The cells of the embryo are small and cubical and filled with dense protoplasm and stored material in the form of aleuron As the embryo has increased in size the number of starch grains has increased only to a slight extent in the nucellus, and the embryo has come to occupy more of the embryo sac thus compressing the endosperm tissue There is no indication, as yet, of this surrounding layer of endosperm having the digestive function suggested by Johnson, since there is no evidence of the cells becoming adapted for that purpose

The mature seeds are smooth, oily, and shiny, being black and kidney-shaped (Fig 8) The micropylar part is short-beaked

extending out over the hilum which occupies a depressed area near one end of the seed The testa is made up of two very well marked regions On the outside are the pillar-like epidermal cells, mentioned earlier in the paper, whose walls have now become dark brown The lateral walls have become somewhat thickened, while the outer walls show a marked increase in thickness, the width of the wall now being equal to about one-fourth the length of the cell (Fig 9) This layer of cells is very hard and brittle because of the presence of calcium silicate in the cell walls These cells are dead and have lost all the brown, granular contents which were evident in the young seed The remainder of the testa consists of several rows of loose, tangentially compressed parenchyma cells whose walls are light brown The nucellus located between the embryo and the testa is now represented by a thin layer of compressed cell remains All the cellular endosperm which surrounded the embryo earlier in the process of development has disappeared except the compressed cell remains about the cotyledon portion of the embryo and a cap-like portion about the terminal half of the hypocotyl This cap-like portion is about six cells in thickness over the end of the embryo, gradually decreasing to one cell in thickness at its margin which clasps the hypocotyl The cells of the endosperm are thin-walled and distorted, containing neither aleuron grains nor starch The nucellus which is encircled by the mature embryo is represented by parenchyma cells which are filled with closely packed starch grains (Fig 10) In the hilum region of the nucellus the starch grains are slightly less abundant

SUMMARY AND CONCLUSIONS

The ovule is a flattened, campylotropous structure and the embryo sac occupies a curved peripheral position in the nucellus The endosperm becomes cellular at an early stage in the development of the seed, but shows no indication of becoming a storage or digestive region at any time during its entire development The early stage of embryo development is quite similar to Bursa As the seed comes to maturity the cellular endosperm is all di-

gested except a cap-like portion of compressed cells over the micropylar end of the hypocotyl At the maturity of the seed the testa is represented by a row of brown pillar-like, brittle cells, and an inner layer of light brown, tangentially compressed parenchyma cells The storage region consists of perisperm in whose cells occur closely packed, large, compound starch grains and also small simple grains

The absence of the digestive layer of endosperm separating the embryo from the perisperm in the mature seed shows that Johnson's suggestion regarding the Phytolaccaceae does not hold true, at least in the very representative species *Phytolacca americana*

Michigan Agricultural College
East Lansing, Michigan

LITERATURE CITED

1 Engler, A, and Prantl, K 1894 Die Naturlichen Pflanzenfamilien III Teil, 1 Halfte, Leipzig

2 Harz, C O 1885 *Landwirthschaftliche Samenkunde* Berlin

3 Johnson, D S 1900 On the Development of Saururus cernuus L Bull Torrey Bot Club, 27 365–372

4 —— 1902 On the Development of Certain Piperaceae Bot Gaz 34 321–338

5 Woodcock, E F 1914 Observations on the Development and Germination of the Seed in Certain Polygonaceae Amer Journ of Bot, 1 454–476

DESCRIPTION OF PLATES

All figures drawn from median longitudinal sections cut parallel to flat surface of seed. The following abbreviations are used E, embryo, ES, embryo sac, M, micropyle, F, funiculus, N, nucellus, EN, endosperm, S, suspensor, P, plumule, PE, perisperm, T, testa, ER, cap of crushed endosperm, OI, outer integument, INI, inner integument, H, hypocotyl, C, cotyledon

PLATE XX

FIG 1 Young ovule, showing embryo sac, spherical embryo, and endosperm in free nuclear condition × 40

FIG 2 Micropylar portion of young ovule shown in Fig 1 × 207

FIG 3 Epidermal cells of outer integument, showing vacuoles filled with large granules × 730

FIG 4 Young seed, showing embryo with cotyledons well developed and embryo sac encircling the nucellus and filled with endosperm cells × 12

FIG 5 Several endosperm cells at stage shown in Fig 4 Note large vacuoles and absence of starch grains × 207

FIG 6. Cell from nucellus at stage shown in Fig 4. Several small, simple starch grains and one large, compound grain present. × 207

PLATE XXI

FIG 7 Micropylar portion of seed at a stage slightly later than that shown in Fig 4 The endosperm is compressed and the plumule is evident at the base of the cotyledons × 40

FIG 8 Mature seed, showing the perisperm as storage region and a cap of endosperm cell, remains over the end of the hypocotyl × 40

FIG 9 Section through testa of mature seed × 207

FIG. 10. Cell from perisperm of mature seed showing simple and compound starch grains. × 430.

PLATE XX

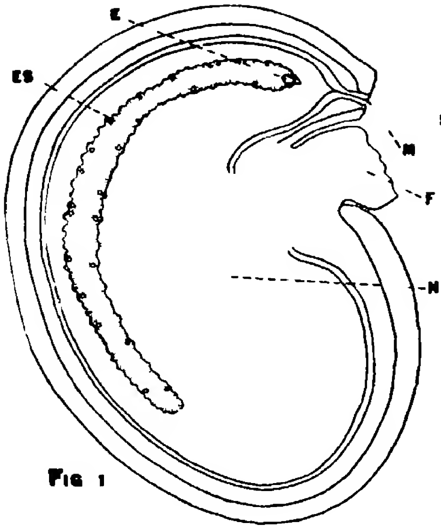


Fig 1

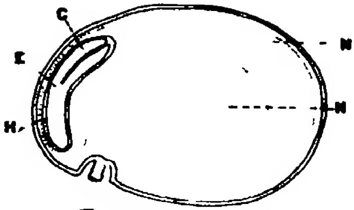


Fig 4

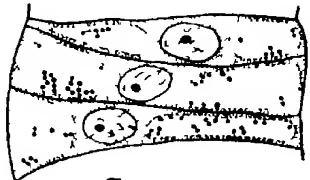


Fig 3

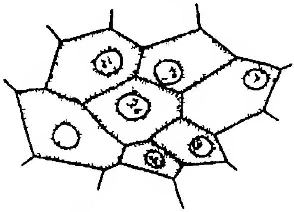


Fig 5

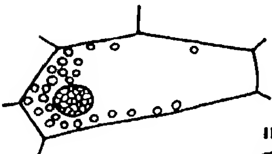


Fig 6

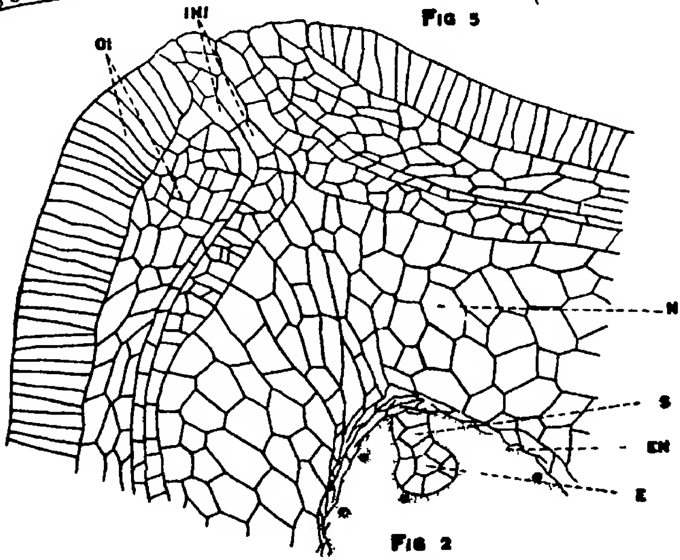


Fig 2

PLATE XXI

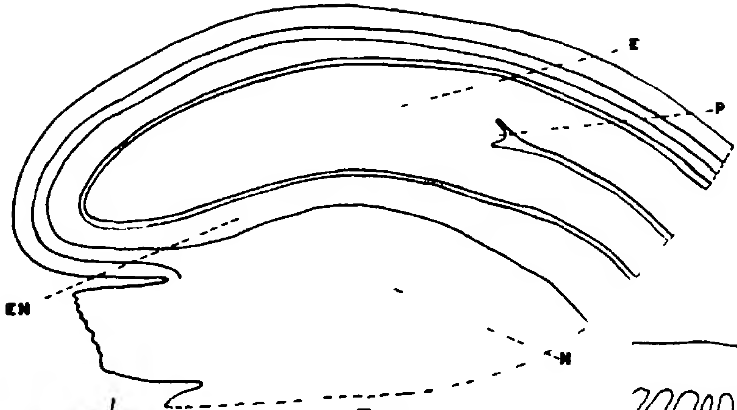


Fig 7

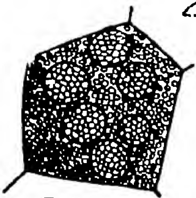


Fig 10

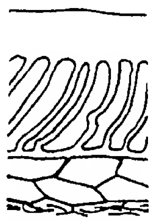


Fig 9

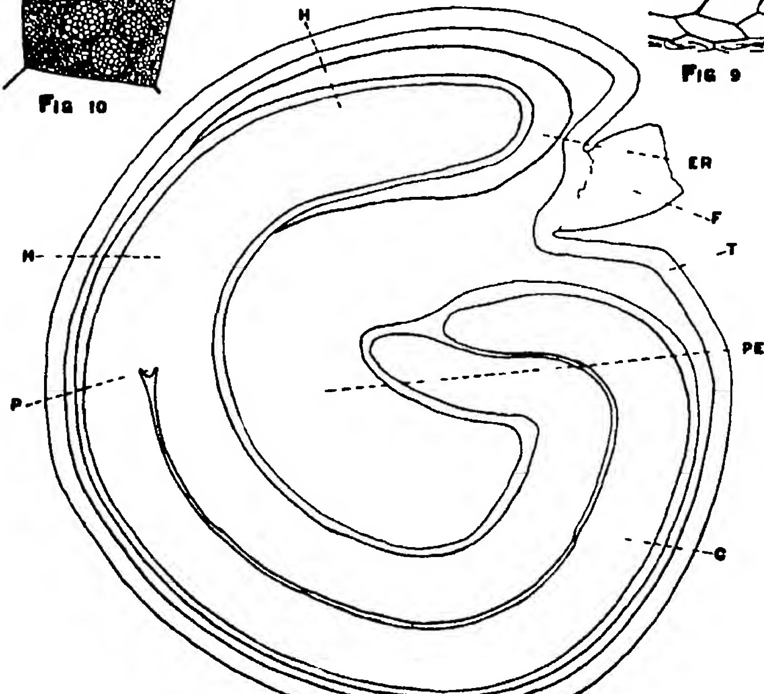


Fig 8

SOME NEW SPECIMENS OF TRIASSIC VERTEBRATES IN THE MUSEUM OF GEOLOGY OF THE UNIVERSITY OF MICHIGAN

E C CASE

THE Museum of Geology of the University of Michigan has recently completed the preparation of several most interesting specimens of Triassic vertebrate fossils, from the Dockum beds of western Texas

The first of these to be described is the lower jaw of a Phytosaur, No 8855, referable to *Leptosuchus crosbiensis* (Pl XXII, Fig 1) The specimen shows the complete left side and the whole of the right side as far back as the symphasis Its chief interest lies in the fact that a large number of the teeth are preserved, from the most anterior to the last posterior one of the left side This permits a thorough understanding of the dentition of the mandible On the left side there are forty-three teeth and sockets posterior to the three large tusks, or forty-six in all, on the same side there are thirty-one teeth and sockets anterior to the symphasis and on the right side there are thirty teeth and sockets in the same space

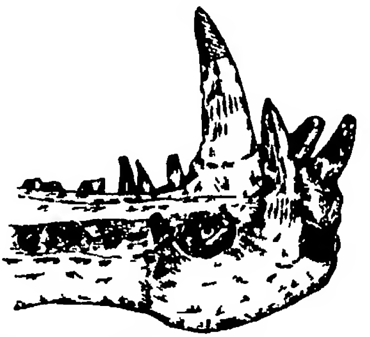


FIG 9 Anterior end of the mandible of *Leptosuchus crosbiensis*, No 8855, University of Michigan × ½

The anterior end of the mandible is slightly expanded and has three large tusks or sockets on each side (Text Figure 9) The two posterior tusks on each side are the larger and, as is so common in the primitive reptilia

and amphibia, were replaced alternately Thus the posterior socket on the left side is occupied by a large functional tusk and the anterior one is occupied by a new one about half-grown, on the right side the anterior socket is occupied by a functionally complete tusk and the posterior one by the apex of one which is just appearing The most anterior tusks are smaller than the two behind and are represented by a complete tooth on the left side and an empty socket on the right side

The teeth immediately posterior to the tusks are very small and conical, or slightly curved conical The reduction in size cannot be in correlation with the tusks of the upper jaw as the latter close in front of the lower tusks The teeth gradually increase in size toward the back of the jaw, retaining the conical form to a point behind the symphasis, but gradually becoming oval in section at the base, with the longest diameter transverse to the long axis of the jaw, this is very marked in the thirtieth tooth In the thirty-first and thirty-second teeth the height has begun to diminish and the section of the base becomes decidedly elongate-oval with the reappearance of serrate cutting edges The thirty-fourth tooth on the left side has the low crown and narrow oval section characteristic of the cheek teeth in all the Phytosauria The greatest diameter of the tooth is still transverse to the axis of the jaw Posterior to this there are two complete teeth and the broken root of a third, all showing the greatest diameter parallel to the edge of the jaw

The anterior tusks are convex externally and more nearly flat internally, near the base, but become more nearly narrow-oval toward the apex The edge formed by the meeting of the two surfaces is sharp and finely serrate In Figure 10 is shown

FIG 10 Cross-sections of various teeth *a*, base of thirty-fourth tooth of left side, *b*, near top of same, *c*, base of tusk of right side, *d*, near middle of same, *e*, near top of left tusk All figures × 1

the section of the two large tusks, *c* and *d* are from near the base and the middle of the tusk of the right side and *e* from near the top of the left tusk Figures *a* and *b* are sections from the thirty-fourth tooth on the left side, at the base and near the top The character of the serrations on the cutting edges is shown in Figure 11

The anterior tooth of the left side is decidedly fluted from the base to the apex, it is more nearly round than the larger tusks, but has distinct cutting edges The larger tusks show broad flutings, faintly marked but distinct The smaller conical teeth are fluted from the base to near the apex, the flutings are low but distinct and are continuous, becoming more crowded near the

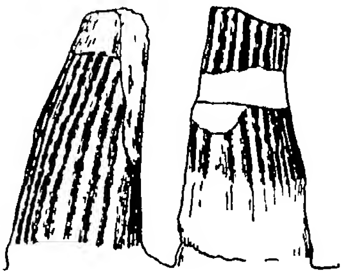


FIG 11 Cutting edge of one of the large tusks, showing character of the serrations × 2½

FIG 12 Seventh and eighth teeth of the right side, showing the character of the fluting × 2½

tip where they disappear either from wear or naturally Figure 12 shows the flutings on the seventh and eighth teeth of the right side

The total length of the lower jaw is 82 cm and the presymphasial portion is 36 5 cm These measurements correspond very closely with those of the holotype of *Leptosuchus crosbiensis* No 7522, University of Michigan

The second specimen to be mentioned is the skull of *Leptosuchus imperfecta*, No 7523, University of Michigan This specimen, Plate XXII, Figure 2, is larger than *Leptosuchus crosbiensis*, having a length of 112 5 cm It was found as a mass of broken fragments and has required a large amount of time to

restore, fortunately, from one side or the other there is complete continuity from the posterior end to the tip of the snout The apparently restored portion near the anterior end of the snout is justified by the continuity of the bone on the under side The chief interest of the specimen lies in the pathological condition of the anterior end of the elevation of the snout As shown in Plate XXIII, Figure 1, the nares are in the normal position and the upper edge of the elevation of the snout runs forward nearly horizontally for a short distance and then descends rapidly to the level of the upper surface of the low rostrum At the angle where the snout begins its descent, there is a heavy rugose swelling of the median bones The rugosities have a roughly radial arrangement from the top downward and outward, the top of the swollen area is occupied by a nearly hemispherical cavity which would just about accommodate a tennis ball The sides of the cavity are smooth, but the surface is porous or spongy instead of hard and glistening, as in normal bone

The presence of this cavity seems explainable only as the result of a pathological condition, the seat either of an abscess of the bone or of a deep-seated tumor In an abscess caused by infection or by injury, the cavity is very irregular and the accompanying exostoses are equally irregular The presence of such an abscess would accord well with the suggestions of Abel, who believes that the various forms assumed by the rostra of the Phytosauria can best be explained as the result of injuries inflicted in battles between members of the same species, probably during the mating season [1] Opposed to this suggestion are the symmetrical character of the cavity, the smooth internal wall, and the rather regular radial arrangement of the rugosities on the outer side of the swelling Doctor A S Warthin, of the Department of Pathology in the University Medical School, has suggested that the smooth cavity may have been the seat of a tumor, an explanation that is much more plausible than that of a simple abscess It is most interesting to note in this connection that even the Phytosauria of the Mystriosuchus type, with the low, slender rostra, have very frequently a low swelling on the

[1] Abel, O *Paleontologische Zeitschrift*, Bd. V, Hft. 1, 1922, s. 26.

upper surface, this has been noted by both Von Huene and the author of this paper

A third specimen of a Phytosaur, No 8853, University of Michigan, is the posterior end of the lower jaw of an individual nearly a fourth larger than *Leptosuchus imperfecta*, this means a skull nearly four and a half feet long, one of the largest that have been recorded

The last specimen to be described is the upper portion of the skull of a very large Stegocephalian, No 8854, University of Michigan, probably specifically identical with the holotype of *Buettneria perfecta* This skull was found in broken fragments and is in part restored, but the restorations of one side are largely from the preserved parts of the other side, only the tip of the nose is entirely restored and this cannot be wrong by more than a few millimeters, as a part of the rim of the external nares is preserved on both sides The character of the skull is shown in the photograph, Plate XXIV, and the restored portions are indicated by dotted shading in Plate XXIII, Figure 2 The specimen very closely resembles the skull of *Buettneria perfecta* in the position and relations of the bones and grooves for the canals of the dermal sensory system [2] The slight differences in the sculpture, the deep grooves accommodating the sutures, in places, and the slight differences in the size and relative position of the orbits may easily be the result of age and growth

The large size of the skull is the most striking feature, in this it approaches some of the largest specimens which have been collected from the European Trias The existence of an amphibian of this size has been previously indicated only by the very large interclavicle, No 7265, University of Michigan, figured by the author of this paper in 1923 [3]

[2] Compare with Figure 1, A and B, *Publication 321*, Carnegie Institution of Washington

[3] *Publication No 321*, Carnegie Institution of Washington, Plate 3, Figure *a*

EXPLANATION OF PLATES

PLATE XXII

FIG 1 Left side of lower jaw of *Leptosuchus crosbiensis*, No 8855, U of M

FIG 2 Left side of skull of *Leptosuchus imperfecta*, No 7523, U of M

PLATE XXIII

FIG 1 Narial region of the skull of *L imperfecta* to show the pathological condition

FIG 2 Outline of the skull of *Buettneria perfecta*, second specimen, No 8854, U of M To show the sutures, sensory canals and the restored portions (shaded)

PLATE XXIV

Photograph of the skull of *Buettneria perfecta*, second specimen, No 8854, U of M Total length, as restored, 56 5 cm

PLATE XXII

FIG 1

FIG 2

PLATE XXIII

FIG 1

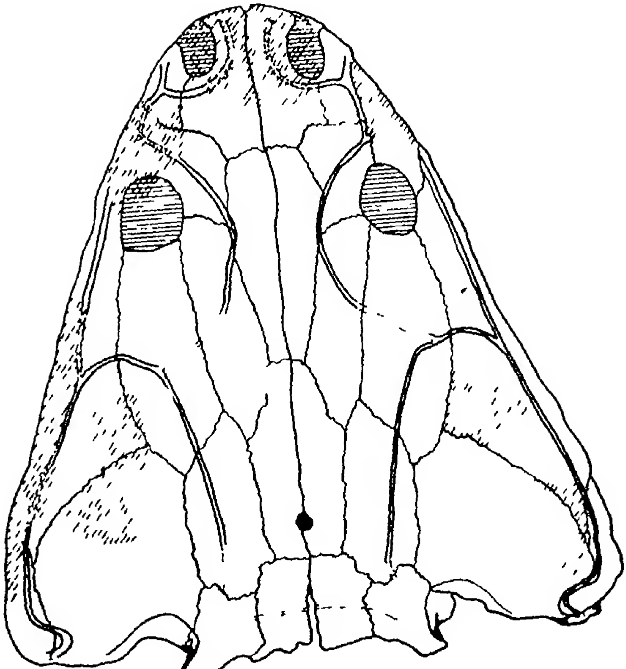
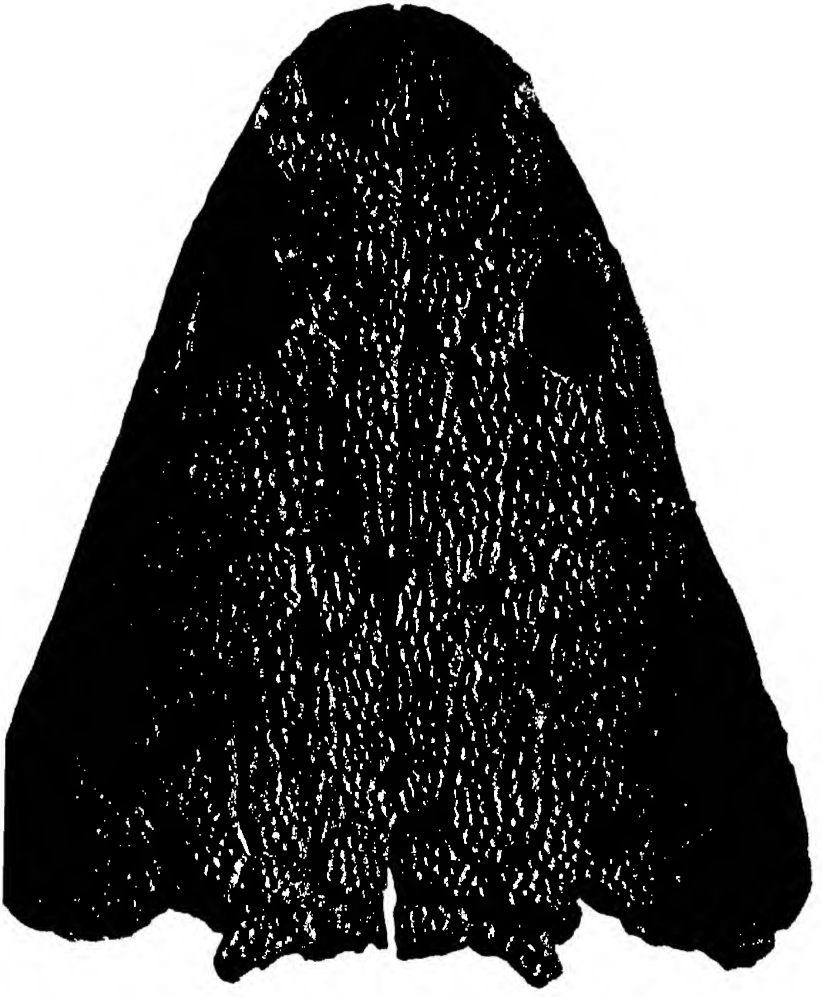


FIG 2

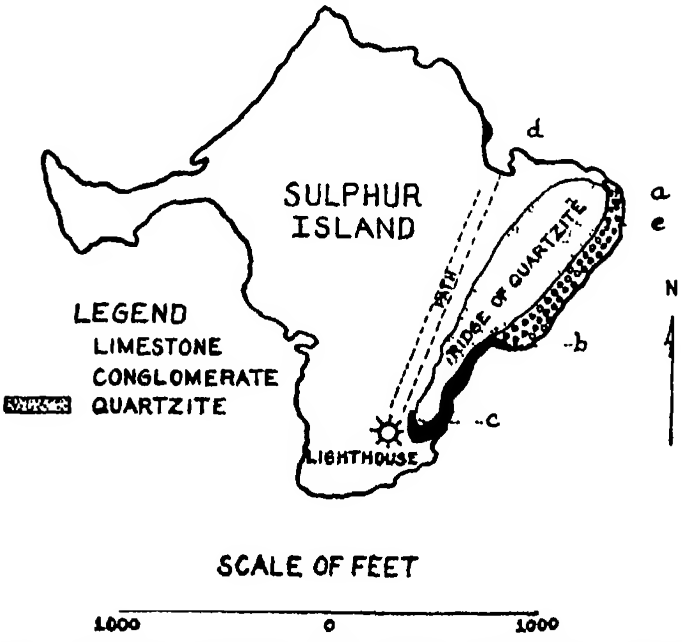
PLATE XXIV



AN ORDOVICIAN REEF ON SULPHUR ISLAND, LAKE HURON

G M EHLERS

THE occurrence of an interesting Ordovician reef on Sulphur Island, which is located in the North Passage of Lake Huron about two and three-quarter miles north and nearly one mile east of Poe Point, Drummond Island, Michigan, was briefly described by Dr Carl Rominger [1] in 1873 Inasmuch as this



MAP III Sketch map of Sulphur Island showing location of quartzite ridge, associated deposits and erosional and depositional features
(U S Lake Survey base with additions)

[1] Dr Carl Rominger, *Paleozoic Rocks Michigan Geological Survey*, Vol. 1, Pt. 3, p 68. 1873

reef and its associated deposits present some unusual features of wave erosion and of sedimentation, a more detailed description accompanied by illustrations may be of interest

On the east side of Sulphur Island (See Map III) is a ridge of thick-bedded, well-jointed, greenish-gray to brown Pre-Cambrian quartzite, the top of which is fifteen to twenty feet above the level of Lake Huron The massive nature and jointing of the quartzite is well shown where it is exposed near the northeast corner of the island (See Plate XXV, Fig 1)

Most of the eastern side of the ridge originally presented a steep face or cliff to a sea, which transgressed over this area in Mid-Ordovician time The waves of this sea pounded against the cliff and by undercutting and erosion along joints dislodged huge blocks of quartzite These large blocks and smaller masses of rock, which were either originally torn from the cliff or reduced in size from the larger ones by wave action, came to rest against the cliff in a rather steeply inclined position In fissures of the cliff, produced by the grinding action of the waves along joints of the quartzite, Dr Rominger found rounded, water-worn pebbles of granitic rocks These probably were carried to the cliff by currents in the sea from near-by ledges, which may now be beneath the surface of the lake or be present on the island covered by other deposits The grinding action of the waves reduced some of the rock of the cliff to a sand, which was carried seaward by the undertow and shore currents

At no great distance from the cliff and over most of the surrounding region covered by the sea, calcium carbonate in the finely divided state of a mud was being deposited Much of the calcareous material or mud became mixed with the sand, which was ground from the cliff and deposited in a relatively narrow zone bordering the debris of quartzite blocks and boulders along the shore

When the wave action on the cliff was greatest, the level of the sea was probably five to ten feet nearer the top of the ridge than the present level of Lake Huron, the ridge at this time appeared as a small island

During an encroachment of the sea, the islet became sub-

merged and hence converted into a reef. As submergence progressed, wave action became less and less effective and deposition of sand and calcareous mud took place. The spaces between the blocks and boulders of quartzite, dislodged from the cliff, were filled with sand, calcareous mud and fragmentary remains of bryozoa, brachiopods and echinoderms which were cast against the reef by storm waves. The conglomerate, composed of the boulders and matrix of sand and calcareous material, as well as the entire reef, very likely became covered by a fairly thick deposit of calcareous mud.

The basal beds of the calcareous mud conform rather closely to the slopes of the reef and conglomerate and as a result are steeply inclined. This agreement in slope is shown fairly well where thin beds of very fossiliferous limestone — the consolidated calcareous mud — rest upon the inclined surface of the conglomerate a short distance northeast of the lighthouse, situated on the southern shore of the island (See Plate XXV, Fig. 2). It is even more evident where the limestone dips away in several directions from a knoll on the quartzite ridge just east of the lighthouse (See Plate XXVI, Fig. 1).

The limestone at the knoll, except for a few sandy beds at its base, rests directly upon quartzite without the intervention of a coarse conglomerate, such as that exposed along the shore a short distance to the northeast. Such a conglomerate, however, very likely occupies a position between the limestones and quartzite a short distance away from the top of the knoll. That wave action was very effective prior to the deposition of the limestone and could have quarried out large masses of rock for subsequent incorporation into a conglomerate, is indicated by the presence of channels cut along joints of the quartzite, by the rounded, wave-worn surfaces of this rock and by wave-dislodged blocks (See Plate XXVI, Fig. 2). The tools of sand and pebbles, used by the waves in their abrasive work and subsequently cemented together by calcareous material upon the submergence of the knoll, may now be seen in the channels cut along the joints of the quartzite.

As the entire reef became more and more submerged, suc-

cessively higher and higher beds of limestone were laid down on its sides with a decreasing angle of repose However, as a result of their partial agreement in slope to those of the reef, the limestones encircling the reef must have assumed the structure of a more or less elongated dome The subsequent removal of most of these limestones by erosion has largely obliterated the dome structure, nevertheless, its former presence is strongly suggested by the radial dip of the limestones, exposed to the east and northeast of the lighthouse, from the southern part of the quartzite ridge — the core of the dome The nature of the structure was probably quite similar to that of a small, partially exposed dome, existing in the limestones on the northeast side of the island (See Plate XXVII, Fig 1) The radial dip of the strata of similar domes would usually be accounted for by pressure, in the case of this dome, however, it certainly results from original deposition on the slopes of a buried knoll of quartzite or possibly granitic rock Incidentally, the buried rock, if it is a granite, may have been the source of the granitic pebbles found by Dr Rominger in the fissures of the quartzite cliff With the increasing submergence of the reef, limestones and perhaps other kinds of sedimentary rocks accumulated over the surrounding area and probably reached the level of the top of the reef Sediments, possibly of considerable thickness, were then probably deposited in a practically horizontal manner over the reef and its associated, inclined strata

With little doubt, seas of late Ordovician and certain Silurian and Devonian times also transgressed over the Sulphur Island region and deposited sediments, whose aggregate thickness was considerable The quartzite ridge may very likely have become buried beneath several hundred feet of these sediments

Some time previous to the coming of the Pleistocene glacier, perhaps during later Paleozoic and all of Mesozoic and Cenozoic times, the Sulphur Island area — in fact most of the Great Lakes region — was maturely dissected by streams The sediments, covering the top of the quartzite ridge, were removed by this erosion Soil, which probably lay upon the ridge just previous to the advance of the ice, and loosened masses of rock on its top

and sides were subsequently removed by the glacier Except for the absence of soil and loosened rocks, the ridge and the inclined beds of conglomerate and limestone on its sides, with little doubt, present much the same appearance today as at the time of the coming of the Pleistocene glacier

With the passing of the great continental glacier, Lake Huron and the other lakes of the Great Lakes system were formed The waves of Lake Huron are especially active today on the eastern side of Sulphur Island, there they are quarrying into the firmly cemented conglomerate, formed during Black River time (See Plate XXVII, Fig 2) Ultimately they will probably tear away the conglomerate and pound against the cliff, exposed long ago to the attack of waves of a marine sea Even the geologist, accustomed to seeing striking and unusual, geological phenomena, experiences a decided thrill on watching the waves of the present fresh water sea in their nearly accomplished effort to reach the cliff and take up the work of quarrying, abandoned by the waves of a marine sea of several millions of years ago

University of Michigan

EXPLANATIONS OF PLATES

PLATE XXV

FIG 1 Massive and well-jointed Pre-Cambrian quartzite exposed at the northeast corner of Sulphur Island View taken at *a*, Map III

FIG 2 Inclined limestone strata, shown at lower center of view, resting on the comglomerate of Black River age The bouldery nature and conspicuous dip of the conglomerate are well shown at the center of the view The quartzite ridge is immediately to the left of the conglomerate but hidden by vegetation View taken at *b*, Map III

PLATE XXVI

FIG 1 Highly inclined limestones resting on Pre-Cambrian quartzite View taken at *c*, Map III

FIG 2 Closer view taken at 1, Plate XXVI, Figure 1, showing effects of wave erosion and nature of deposition The channel along one of the joints of the quartzite, shown in the foreground of the view, the two dislodged blocks to the left and the rounded surfaces of the quartzite are the result of wave erosion prior to the deposition of the thin-bedded limestone The lighter colored material, shown in the channel, is limestone and serves as a cement for sand and gravel, used as tools by the waves in their abrasive work Note the influence of the block of quartzite on the dip of the large mass of limestone

PLATE XXVII

FIG 1 Small dome in Black River limestone, resulting from deposition on inclined surfaces of an underlying knoll of Pre-Cambrian quartzite or granite View taken at *d*, Map III

FIG 2 Section of the Black River conglomerate cut by storm waves of Lake Huron The cliff, formerly exposed to the pounding waves of the Black River sea, is only a short distance behind the conglomerate Further cutting by the waves of Lake Huron may again expose the cliff to attack The rounding and reduction in size of the blocks in the foreground, abandoned by waves of the Black River sea, are now being continued by storm waves of the lake View taken at *e*, Map III

PLATE XXV

Fig. 1

Fig. 2

PLATE XXVI

FIG. 1

FIG. 2

PLATE XXVII

Fig 1

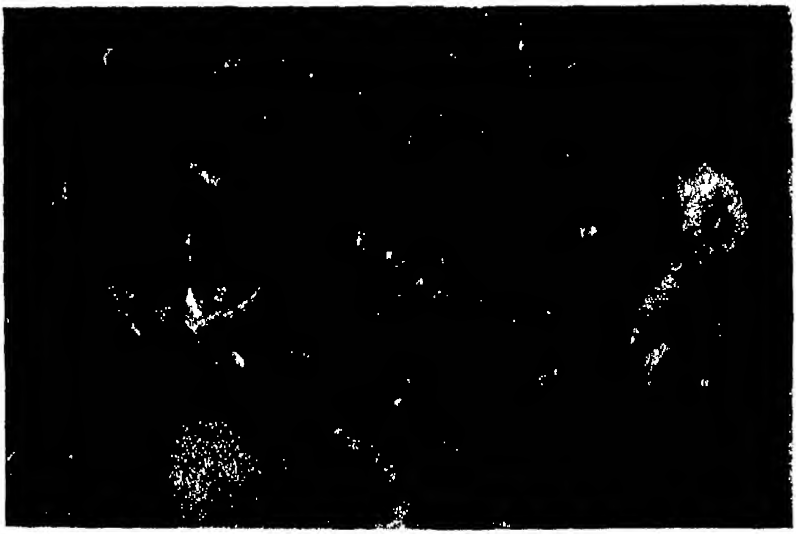


Fig 2

DEISM BEFORE LORD HERBERT

LOUIS I BREDVOLD

My purpose in this somewhat fragmentary paper is twofold first, to suggest, on the basis of some scattered evidence, that Deism was of Continental origin and that it had a rather extended, though secret, following earlier than the publication of Lord Herbert's famous book in 1624, secondly, to call attention to a neglected sixteenth century treatise on Deism, which was first published from manuscript in 1836 in the *Zeitschrift für die historische Theologie*, and has ever since escaped the notice of writers on Deism

There is, in the first place, a quite general impression that Lord Herbert of Cherbury was the "parent" or "founder" of Deism [1] Occasionally someone goes further, as Pünjer, in his *History of the Christian Philosophy of Religion*, who says that the roots of Deism "lay in the sober, practical, common-sense character of the English people, and its beginnings took their rise in the characteristic movement of the English Reformation" [2] Other students, it is true, have noticed similar developments on the continent,[3] but the nearest approach to the contention of the present paper is the statement in the article on *Deism* in the *Encyclopedia Britannica* (11th edition) "the deistic standpoint had already been foreshadowed to some extent by Averroists, by Italian writers like Boccaccio and Petrarch, in More's *Utopia* (1515), and by French writers like Montaigne, Charron and Bodin"

[1] So Erdmann, *Hist of Phil* (London, 1891), II, 153, and the article on *Deism* in the *Encyclopaedia of Religion and Ethics* (N Y, 1914)

[2] Pünjer, trans. Hastie (Edinburgh, 1887), p 284

[3] Lechler, *Geschichte des Englischen Deismus* (1841), discusses the "preparation for Deism" in England and France, and Höffding, *Hist of Mod Philosophy* (London, 1908), I, 59 ff, groups Lord Herbert and Bodin under "natural religion," and recognizes the free thought of the Renaissance

The tendency to regard Deism as English in nature and origin can be variously explained. In its flourishing period in the eighteenth century, when it reached its greatest philosophical and literary expression, it was a distinctly English movement, and from England was disseminated throughout Europe, and when we think of Deism, we consequently usually think of eighteenth-century England. But perhaps an equally significant explanation lies in the obscurity of its origins. The sixteenth century, a period of feverish intellectual activity, was also a period of feverish persecution. In England, as well as in France, Geneva and Rome, intolerance in religion was the accepted principle, and our path through the century is lighted by fires and human sacrifices. How effective this repression really was, can probably never be told, but it unquestionably prevented the publication of very important elements of Renaissance thought. For there seems to have been a large and growing class who, in spite of the statutes, held and propagated more or less secretly all sorts of dangerous heresies. In 1623 Père Mersenne estimated that there were fifty thousand atheists in Paris.[4] If this seems rhetorical exaggeration, we have the statement made a generation earlier by the Huguenot leader, La Noue, that the French wars of religion had produced a million "Epicureans and Libertines."[5] But these emancipated and sceptical gentlemen of the Renaissance rarely wrote and hardly ever printed, and it is therefore extremely difficult to ascertain what their ideas really were. To interpret correctly the meagre evidence as to the circulation of distinctly Deistic ideas in the Renaissance, it must be placed in its proper setting.

It is necessary, of course, to distinguish Deism clearly from similiar or related tendencies, such as Arianism, Socinianism, or mere rationalism. In the first place, Deism involved a criticism of the special beliefs of every revealed religion, whether Christi-

[4] F. Strowski, *Pascal et son Temps* (Paris, 1907), I, 138–9.

[5] "Si on demande qui a produit une telle generation, on ne respondra pas mal, que ce sont nos guerres pour la Religion, qui nous ont fait oublier la Religion. . . . Entre ses autres fruits, la guerre civile a aporté cestui-ci, d'auoir engendré un milion d'Epicuriens & Libertins." — *Discours Politiques et Militaires du Seigneur de la Noue* (Basle, 1587), pp. 6, 34.

anity or Judaism or Mohammedanism The Deists were adepts, considering the state of scholarship of that time, in higher criticism They aimed to destroy what they thought the falsifications of essential religion But though they showed themselves sceptical towards historical religions, they had at first also a different aim very closely at heart, to purify universal religion from the corruptions of organizations and priesthoods True religion, they held, is natural religion, universally revealed to all men and sufficient for salvation Religion was thus based on the Stoic conception of Universal Reason, and Deism was, on its constructive side, a religious rationalism [6] Herbert reduced religion to his famous five propositions, which he considered undeniable, and which all mankind must needs acknowledge by unaided reason

1 That there is one supreme God,

2 That he ought to be worshipped,

3 That virtue and piety are the chief parts of divine worship,

4 That we ought to be sorry for our sins and repent of them,

5 That Divine Goodness dispenses rewards and punishments both in this life and after it [7]

By thus distinguishing between essentials and superstitions, the Deists sought to restore religion to its integrity and purity and universality They opposed not only priesthoods, but athe-

[6] Dilthey, in his *Weltanschauung und Analyse des Menschen seit Renaissance und Reformation* (Leipzig, 1914), pp 45 ff, discusses a somewhat wider conception which he calls "der religiös universalistischen Theismus," that is, "die Ueberzeugung, dass die Gottheit in den verscihedenen Religionen und Philosophen gleicheswreise wirksam gewesen sei und noch heute wirke" He names Erasmus and Reuchlin among the adherents of this Theism I think the early Deists can be distinguished from these milder Theists as more sceptical in their rejection of the peculiar tenets of Christianity, Islamism, or any other historical religion, and also more rationalistic, in their insistence on the universal revelation and self-evident truth of natural religion

[7] Herbert, *De Veritate* (London, 1645), p 222. "Hae autem sunt omnino *Notitiae Communes*, ex quibus *vera Ecclesia Catholica* sive *universalis* constat" Herbert's criticism of Christianity is rather unmistakably implied than definitely expressed. But his animus against the clerical profession seems evident enough in *The Ancient Religion of the Gentiles* See, for instance, pp 271 and 354 of the English translation (London, 1705)

ists, and were by no means antinomian in their ethical tendencies The Stoic theory of Nature as Universal Reason to which, as has been said, Deism was allied, was the basic principle in European ethical and legal thought from the Middle Ages down into the eighteenth century [8]

It was, however, the sceptical and critical spirit which developed first, and we must seek its origins in the Middle Ages "Le XVIe siècle," according to Renan,[9] "n'a eu aucune mauvaise pensée que le XIIIe n'ait eue avant lui " It is not difficult to see how a critical and comparative study of religions should develop so early The medieval Christian church aimed at an intellectual unity of mankind under the leadership of its own doctors But this Christian supremacy was challenged by the spirit of secular philosophy, which was abroad even then, there were also, here and there, educated Jews who clung tenaciously to their own religion and philosophy, and in the thirteenth century Europe had forced upon it a new respect for the Mohammedans and their religion, partly because of contact with them during the Crusades, and partly because the Arabs were the possessors of the great treasures of ancient learning, especially the true Aristotle The new tolerance towards these enemies of Christianity, the open-minded interest in them, necessitated such a rational defense of the superiority of Christianity as the *Summa contra Gentiles*, by Thomas Aquinas But even before Aquinas, already in the twelfth century, there were treatises written on the subject, cast in the dialogue form, each point of view being championed by an adherent Gilbert Crispin, Abbot of Westminster, disciple of Anselm, wrote two one between a Christian and a Jew, and another between a Christian and a philosopher In the latter the Christian fails to convert the philosopher, who "rose and departed I know not whither, downcast alike in mind and countenance " [10]

[8] This aspect of Deism has been especially emphasized by Höffding, ed cit , I, 59 ff , and by Windelband, *Hist of Phil* (New York, 1893), p 436

[9] *Averroès et l'Averroïsme*, p 231

[10] Webb, C C J , *Studies in the History of Natural Theology* (Oxford, 1915), pp 194–198 On similar dialogues in early Christian literature, see Rudolf Hirzel, *Der Dialog* (Leipzig, 1895), II, 367 ff

Abelard combined these two situations in his Dialogue between a Christian, a Jew and a Philosopher. He represents himself as dreaming that these three men, in various ways the worshippers of one God, ask him to judge between them. The philosopher presents a religion based on Natural Law, and declares that custom and education are largely responsible for the hold Judaism and Christianity have on their people. The Jew maintains that the Philosopher is unable to disprove the divine origin of the Jewish faith, and the Christian defends his own beliefs chiefly on the basis of the superiority of Christ's ethical teaching. All three participants proceed on the assumption that all religious doctrine, if not absolutely demonstrable, is at least accessible to reason, and the spirit throughout is amicable and fair.[11]

Both Crispin and Abelard were Christian and Orthodox, at least in intention. But we can trace with quite remarkable accuracy the spread of the heretical idea of the equality of Christianity, Judaism and Mohammedanism in the successive versions of the widely circulated story of the three rings,[12] used again by Lessing in *Nathan der Weise*. In its earliest versions the tale is clearly Christian. The three chief religions were compared to three rings given by a father to his three sons, so that after his death the true heir might be identified by the genuine one. Although they are alike in appearance, the true ring is discoverable by its healing power. In this form the story is told by Stephen of Bourbon (died about 1261),[13] by the unknown author of an old French poem about twenty-five years later,[14] and found its way into the *Gesta Romanorum*, in which the application is made as follows: "My beloved, the Knight is Christ; the three sons are the Jews, Saracens, and Christians; the most valuable ring is faith, which is the property only of the younger; that is, of the Christians."[15]

[11] Webb, pp. 207–232. Pünjer, pp. 38–39.

[12] Best brief discussion, with bibliography, in A. C. Lee, *The Decameron: Its Sources and Analogues* (London, 1909), pp. 6–13.

[13] Gaston Paris, *Poésie du Moyen Âge: Lectures et Leçons*, 2me série, 2nd ed. (Paris, 1903), p. 141.

[14] *Li dis dou vrai aniel*, ed. Tobler (Leipzig, 1871).

[15] Lee, p. 8.

Early in the fourteenth century the story was included in the Italian compilation, *Le Cento Novelle Antiche,*[16] but with a new framework and a new conclusion It is there told by a wealthy Jew, who is asked by a grasping sultan the embarrassing question, What is the true religion? Whichever way he answers, he will give the sultan a pretext for confiscating his wealth The Jew shrewdly replies with this story of a father who gave his sons three rings, two of which were imitations of the original genuine one This non-Christian framework betrays the Oriental influence which has now taken possession of the story, the conclusion is no longer Christian, the rings are indistinguishable, and only the father could ever tell the original from the imitations [17]

This version is by some scholars believed to be the source of Boccaccio's tale in the *Decameron* But others point out that a fuller version exists in Busone da Gubbio's *Avventuroso Ciciliano*, and still others think that the story was so widely current in this sceptical form that Boccaccio was indebted to an oral tradition, which perhaps had in it elements of Rabbinical origin [18] In the conclusion of Boccaccio's story we have even more clearly and emphatically stated the tolerant notion that there is some truth in all religions, and that the pretensions of each to be alone genuine cannot be substantiated "E così vi dico, signor mio, delle tre Leggi alli tre popoli date da Dio Padre, delle quali la quistion proponeste ciascuno la sua eredità, la sua vera Legge, et i suoi commandamenti si crede ávere a fare, ma chi se l'abbia, come degli anelli, ancora ne pende la quistione " [19]

This comparative view of religions implied of course that there was falsehood as well as truth in all religions, and for the existence in the Middle Ages of this more emphatically sceptical tendency, we have evidence in the legend of the notorious *De*

[16] No 73 in the edition in *Bibliotheca Romanica*

[17] On the influence of Arabian culture on this idea of comparative religion, see Renan, *op cit*, pp 278 ff

[18] Burckhardt, *Civilisation of the Renaissance in Italy* (London, 1909), p 493 and Lee, pp 11–12

[19] *Il Decameron*, Giornata prima, novella terza.

Tribus Impostoribus, said to have had its origin at the court of Frederick II, the most cosmopolitan in Europe, by one tradition the book is ascribed to the monarch himself[20] The three impostors were of course Jesus, Mohammed and Moses, the founders of the three religions This peculiar treatise was mysteriously referred to as a scandal from the thirteenth century on through the Renaissance, in the seventeenth and eighteenth centuries there was a protracted debate as to whether the book had ever existed One early printed copy, bearing the doubtful date 1598, has indeed been discovered and reprinted,[21] but the question of its authenticity need not detain us, as the work had its chief influence as a legend The title was everywhere known and almost proverbial in its force, and the sceptical ideas which it represented had an underground circulation in the Renaissance, to an extent of which we can now form no definite notion[22]

The general dissemination of such religious liberalism, first in Italy, then in France and England, explains in large part the pagan spirit of Renaissance literature It is unnecessary here to discuss it in detail We find it expressed in Italy, with levity in Pulci's burlesque epic, with seriousness in Pomponatius, who soon after 1500 cast the horoscope of Christianity and presaged its early decline and dissolution[23] In Sir Thomas More's *Utopia* the religion of "the most and wisest part" of the people was ap-

[20] Émile Gebhart, *Mystics and Heretics in Italy* (London, 1922), Chap IV

[21] *De Tribus Impostoribus*, ed. G Brunet (Paris, 1861) Also by Philomneste Junior, *Le Traité des Trois Imposteurs* (Paris, 1867)

[22] See account in *Realencyclopädie für prot Theologie und Kirche* (3d ed , Leipzig, 1901), IX, 72 ff Cf F Picavet "D'abord il fut question d'une affirmation, puis d'un livre successivement attribué à Averroès, à Frédéric II, à Pierre des Vignes, à Arnauld de Villeneuve, à Boccacce et à Pogge, à Pierre Aretin, à Machiavel, à Pomponace et à Cardan, à Servet et à Guillaume Postel, à Campanella et à Giordano Bruno, à Spinoza, à Hobbes et à Vanini Et Mersenne disait l'avoir vu en arabe! Une telle énumération, qui est loin d'être complète, prouve amplement déjà qu'il convient de reconnaître la continuité de la pensée dans le monde de l'Occident du XIIIe au XVIIe siècle" In *Essais sur l'histoire générale et comparée des Théologies et des Philosophies Médiévales* (Paris, 1913), p 314

[23] A H Douglas, *Pietro Pomponazzi* (Cambridge, 1910), pp 300 ff On Italian thought in the sixteenth century, see J R Charbonnel, *La Pensée Italienne au XVIe Siècle et le Courant Libertin* (Paris, 1919)

parently a form of deism More strikingly still, in an imaginary dialogue between Lupset and Cardinal Pole, Thomas Starkey, a contemporary of More, makes the learned and pious Lupset present a Deistic conception of religion as based explicitly on the Stoic notion of the Law of Nature

"In so much," Lupset is made to say, "that the Jue, Sarasyn, Turke, and More, so long as they obserue theyr cyuyle ordynance and statutys, deuysed by theyr old fatherys in euery secte, dyrectyng them to the law of nature, so long, I say, ther be men wych ernystely affyrme them to lyue wel, and euery one in hys secte to be sauyd, and non to perysch utturly, seying the infynyte gudnes of God hathe no les made them aftur hys owne ymage and forme, then he hath made the Chrystun man, and the most parte of them neuer, perauentur, hard of the law of Chryst Wherfor, so long as they lyue aftur the law of nature, obseruyng also theyr cyuyle ordynance, as mean to bryng them to the end of the same, they schal not be damnyd Thys I haue hard the opynyon of grete wyse men, wel ponderyng the gudnes of God and of nature, but whether hyt be so or not, let us, aftur the mynd of Sayn Poule, leue thys to the secrete jugement of God " [24]

More and Starkey wrote in the spirit of the enlightenment of the earlier Renaissance, before the fierce conflicts of the Reformation brought more rigid discipline into intellectual and ecclesiastical ranks, before the spirit of tolerance was lost in persecution and the turmoil of religious wars

But as the religious dissension of the sixteenth century resulted in the formation of innumerable other sects, whose principles were not always novel, so Deism also developed its own sect and movement Leland, the first English historian of Deism, gives the following account of its origin

"The name of Deists," he says, "as applied to those who are no friends to revealed religion, is said to have been first assumed about the middle of the sixteenth century, by some Gentlemen in *France* and *Italy*, who were willing to cover their opposition to the Christian revelation by a more honourable name than that of Atheists. One of the first authors, as far as I can find, that makes express mention of them is *Viret*, a divine of great eminence, among the first Reformers, who in the epistle dedicatory prefixed to the second tome of his *Instruction Chrétienne*, which was published in 1563, speaks of some persons in that time who called themselves by a new name, that of Deists. These, he tells us, professed to believe a God, but shewed no regard to Jesus Christ, and considered the doctrine of the apostles and evangelists

---

[24] *England in the Reign of King Henry the Eighth*, ed. Cowper, Early English Text Society (London, 1878), pp 19–20

as fables and dreams He adds, that they laugh'd at all religion, notwithstanding they conformed themselves, with regard to the outward appearance, to the religion of those with whom they were obliged to live, or whom they were desirous of pleasing, or whom they feared Some of them, as he observes, professed to believe the immortality of the soul, others were of the Epicurean opinion in this point, as well as about the providence of God with respect to mankind, as if he did not concern himself in the government of human affairs He adds, that *many among them set up for learning and philosophy*, and were looked upon to be persons of an acute and subtil genius, and that not content to perish alone in their error, they took pains to spread the poison, and to infect and corrupt others by their impious discourses and bad examples " [25]

This account by Leland, interesting and valuable as it is, is based entirely on the hostile source, Viret's preface, and needs therefore to be documented and corroborated But in the sixteenth century, the possession as well as the publication of a really heretical book was at the risk of one's life [26] In the nature of the case, therefore, the necessary documents must be rare, we are perhaps fortunate to have even two extended contemporary treatises, both of which remained in manuscript until the nineteenth century, on which we may rely as primary sources in our account of the temper and doctrines of the sixteenth century Deists

One of these, Bodin's *Heptaplomeres*, has been discussed by several writers in the last century, and its contents are well known to students of the subject [27] The seven characters of the dialogue represent seven distinct types of religious thought known to Bodin Roman Catholicism, Zwinglianism, Lutheranism, Mohammedanism, the Jewish religion, Deism and a scep-

[25] John Leland, *A View of the Deistical Writers* (London, 1754) I, 2–3 Leland gives Bayle's *Dictionary* as his authority for this account. See under *Viret*, note D

[26] The cases of Kyd and Marlowe in England in 1593 are illustrative See account by F S Boas, in his edition of Kyd (Oxford, 1901) Cf *Studies in Philology*, XX, 153 ff

[27] It was edited from manuscript by G E Guhrauer, *Das Heptaplomeres des Jean Bodin* (Berlin, 1841) An old French translation has been published in part by Roger Chauviré, *Colloque de Jean Bodin* (Paris, 1914) See also Baudrillart, *J. Bodin et son Temps* (Paris, 1853), F V Bezold, *Jean Bodins Heptaplomeres und der Atheismus des 16 Jahrhunderts*, *Historische Zeitschrift*, vols. 113–114, Höffding, op. cit I, 59–63, and Chauviré, *Jean Bodin* (Paris, 1914)

tical naturalism The examination of the doctrines of Christianity from various points of view is free and even at times irreverent, exempting nothing from argument or ridicule At the conclusion every disputant leaves with his ideas unchanged, and the author of the dialogue expresses no explicit preference for the opinions of any one of his characters Yet it seems clear, both from the conduct and spirit of the discussion, as well as from a comparison with Bodin's other works, that the Deist comes nearer than any other to the real opinions of the author [28] However that may be, the Deist, though he is not so called, is here a Renaissance type drawn by a contemporary He contends for natural religion "Si la véritable religion est la naturelle," he says, "laquelle se fait assez connaître d'elle-même, qu'est-il besoin de Jupiter, de Christ, de Mahomet, et de se feindre des dieux qui ont été mortels comme nous?" [29] All men, he repeatedly declares, who have believed in one God, who have lived according to the morality revealed in the Law of Nature, all such men, whether sages of antiquity or patriarchs of the Bible, will be saved His is the theme of universal, natural religion It is Deism clearly and firmly stated

More conclusive than Bodin's dialogue is the treatise published in 1836 from a sixteenth century manuscript, and since apparently forgotten [30] The complexion of this anonymous work is indicated somewhat by the fact that in the same manuscript with it was a copy of the *Liber de' Tribus Impostoribus* It consists of four parts, of which the first, third and fourth are a criticism of Christian doctrines and Biblical history The second part under the title *Vera, divina, antiquissima et perfectissima doctrina de Deo et voluntate eius*, is a systematic statement of the

[28] Baudrillart, *op cit*, p 200 Chauviré thinks this "déisme philosophique" is somewhat influenced by what Bodin believed was the primitive cult of the Jews See *Jean Bodin*, p 160

[29] Passage translated by Baudrillart, p 220

[30] *Origo et fundamenta religionis Christianae*, ed August Gfrörer, in *Zeitschrift für die historische Theologie* (Leipzig, 1836), VI, 180–259 The editor was librarian at Stuttgart The manuscript, a poor grade of old paper, was given him by "a friend." Indorsements dated 1635 and 1587 were accepted by him as genuine.

Deistic creed The first paragraph, with its definition of God as Creator or First Cause, and its somewhat utilitarian estimate of the value of God for man, gives us at once the atmosphere of the later period of the Enlightenment

Cum coelum, maximum et splendidissimum hoc opus, contemplamur, praeterea solem, lunam et stellas, quae in coelo sunt, et consideramus, quam pulcherrimo, certissimo et constanti ordine et motu moveantur oportet nos fateri, esse aliquid et quidem optimum, potentissimum et sapientissimum, quod tanta et tam splendida opera condidit, eaque in tam pulcherrimo, certo et constanti ordine et motu conservat, id quod Deum appellamus

Deinde cum consideramus, ad cuius utilitatem et usum mundus et quaecunque sunt in mundo condita sint, reperimus, propter hominem omnia condita esse, etc [31]

Such a God is knowable by unaided reason, all his essential attributes are demonstrable

"Id docet nos ratio," so the author summarizes his own argument, "Deum esse essentiam infinitam, aeternam, optimam, potentissimam, sapientissimam et iustissimam, quae non tantum omnia creavit, sed eadem etiam nunc sustentat, regit et conservat, atque adeo etiam cogitationes omnium hominum novit, qui bona et iusta amat et praemiis ornat, iniusta vero aversatur et punit " [32]

As the attributes of God are discoverable in nature, so the moral law is identical with the universal and rational Law of Nature, the Stoic conception which, as has been said, exercised such a profound and powerful influence on Renaissance thought "Nos *natura* et *ratio* docet, quid et qualis sit Deus, et quae sit eius voluntas, item quid sit iustum, quid iniustum, quid Deo, quid hominibus debeamus " [33] This revelation of God by means of nature and reason was obscured in man because of his depraved morals and customs, and therefore it had to be repeated through Moses and the prophets, but these holy men did not add anything to what had already been revealed from the beginning

Quod vero Moses de Deo et voluntate Dei non alia neque plura docuerit, quam nos natura et ratio docet, id manifestum est ex *Decalogo*, qui est nobis natura notus et insitus, atque ideo omnes homines omnibus temporibus obligavit et obligat, et est praecipuum et summa doctrinae Mosaicae, ita ut tota doctrina Mosis de Deo et voluntate Dei in Decalogo comprehendatur [34]

---

[31] *Ibid.*, p 235.
[32] *Ibid.*, p 236.
[33] *Ibid*, p 241
[34] *Ibid.*, p 241

The most primitive religion is also the truest in another respect, in its freedom from ceremonial or sacrament, such as baptism and circumcision "Atque ita redibimus ad statum primorum hominum, qui etiam hunc naturalem et rationalem cultum Dei habuerunt, nec ullo initiationis signo usi sunt "[35]

Such were the advanced ideas which circulated among the Renaissance "atheists" and "Epicureans" As we read this anonymous treatise, we can overhear those many discussions behind closed doors, both in England and on the Continent during the Renaissance, when, within small groups of trusted friends, new ideas were exchanged at the peril of the stake With the gradual extension of freedom of thought, these Deistic ideas must have acquired a wider and more open circulation It seems indeed highly probable that Lord Herbert of Cherbury, during his long residence in Paris, should have taken part in such discussions and thus become indebted to a Deistic tradition which, because of the intolerance of the age, had long been transmitted orally[36] This Deistic tradition, I wish to emphasize again, was not English in origin, and it went back further than the seventeenth century Like some other phases of the eighteenth century, it must be regarded as a continuation of tendencies already present in the Renaissance and the Middle Ages Viewed in this comprehensive way, Deism will appear as a necessary stage in the evolution of the modern mind

[35] *Ibid*, p 244

[36] Strowski discusses the Deistic leanings in Charron in *Pascal et son Temps* (Paris, 1909), I, 184 ff M F Lachèvre recently discovered a poem which was notorious about 1622, called *L'Antibigot ou les Quatrains du déiste*, and published it in his *Voltaire mourant* (Paris, 1908), pp 99–135.

UNIVERSITY OF MICHIGAN

BROWNING'S CONCEPTION OF LOVE AS REPRESENTED IN *PARACELSUS*

WILLIAM O RAYMOND

THE importance of *Paracelsus*, as containing an initial but surprisingly mature statement of Browning's outlook on life, and a significant expression of his artistic interests and intellectual convictions, has been generally recognized Though the poem was composed in his twenty-third year, Browning may be said to have established definitely in it the basis of his reflective thought on the fundamental problems of humanity Few writers have oriented themselves so completely at such a youthful age While further elaborated in his later works and given a different setting, practically all of the leading and controlling ideas of his poetry are present in *Paracelsus* As Stopford Brooke states it "When *Paracelsus* was published in 1835 Browning had fully thought out, and in that poem fully expressed, his theory of God's relation to man, and of man's relation to the universe around him, to his fellow men, and to the world beyond "[1]

In particular, *Paracelsus* is noteworthy through its emphasis of what has been called "the richest vein of pure ore in Browning's poetry," namely, the poet's view of the nature and function of love

The primary truth or essential thought underlying Browning's presentation of the career of the Renaissance scholar and physician is so plainly indicated, that it is impossible to mistake it Through his exclusive devotion to the pursuit of knowledge, Paracelsus leaves love out of his scheme of life On ac-

[1] Stopford Brooke, *The Poetry of Robert Browning* (London, 1905), p 23. In a similar vein Hugh Walker writes of *Paracelsus*, in *The Greater Victorian Poets* "That wonderful poem is so near the front of its author's writings, that we may almost say he appears in it complete and perfect "

count of this tragic error he is brought to the verge of ruin, despite the splendid endowment and magnificent aspiration of his genius Two principles, knowledge and love, are constantly contrasted throughout the course of the poem, and the ambitions of two individuals, Paracelsus and the poet Aprile, represent the quest of these great ideals But while the main thesis of the poem, that love must be added to knowledge in order to secure a harmonious development of life and attain its true goal, is sufficiently plain, the precise significance and full import of Browning's conception of love, as set forth in *Paracelsus*, are by no means so self-evident For instance, it has been generally assumed that there is a single and unified view of love running through *Paracelsus* from start to finish Is this the case? Is Aprile, with his ardent longings and impassioned visions, an adequate embodiment of Browning's notion of love as expressed throughout the entire poem? More particularly, is the idea of love, as expounded in the speech of the dying Paracelsus in the fifth canto, identical with that put on the lips of Aprile in the second canto? It is, of course, obvious that Aprile is introduced as a foil to Paracelsus, and that in a general way he typifies the votary of love, as Paracelsus the seeker after knowledge Moreover, so far as the two characters and their ambitions illustrate the pursuit of love and knowledge, each is the complement of the other, and the fusion of their aims would lead to a true understanding and adequate fruition of life

Par 'Love me henceforth, Aprile, while I learn
To love,
I too have sought to Know as thou to Love —
Excluding love as thou refusedst knowledge
Still thou hast beauty and I power'

'Die not, Aprile! We must never part.
Are we not halves of one dissevered world,
Whom this strange chance unites once more? Part? never!
Till thou the lover, know, and I, the knower,
Love — until both are saved'[1]

[1] *Paracelsus*, Part II.

Yet, while admitting the force of these passages, is it possible to show that the contrast between Paracelsus and Aprile is consistently maintained in the details of the poem? Is the fundamental error of Paracelsus due to a failure to grasp the particular conception of love represented by Aprile and his aspirations? Is Aprile's own downfall to be attributed primarily to a neglect of knowledge, or is it the result of an imperfect comprehension of the full truth concerning the nature of love?

There has been a divergence of critical opinion regarding the emphasis to be placed on the part played by Aprile in the poem, and its contribution to the final "attainment" of Paracelsus.

Edward Dowden, who thinks that the whole scene in the house of the Greek conjurer at Constantinople "leaves a painful impression of unreality," writes as follows of Aprile: "The lover here is typified in the artist, but the artist may be as haughtily isolated from true human love as the man of science, and the fellowship with his kind which Paracelsus needs can be poorly learnt from such a distracted creature as Aprile." [3]

One of the most interesting and able attempts to show that Browning's delineation of Aprile embodies the central teaching of the poem regarding the nature of love, was made by Josiah Royce, in an article entitled *The Problem of Paracelsus*, published in *The Boston Browning Society Papers*.[4] I shall quote from Professor Royce's article the more freely, in that I differ from his main conclusion, that the key to the problem of Paracelsus is to be found in the second canto of the work. It is, I shall try to show, by comparing the second with the fifth canto, and by recognizing that there is a complex rather than a uniform representation of love involved, that the apparent inconsistencies of the poem can be explained.

After stating that the whole tragedy of *Paracelsus* turns explicitly upon the poetic antithesis between 'loving' and 'knowing,' Royce points out, that Browning meant much more by this than "the comparatively shallow and abstract platitude

[3] Edward Dowden, *The Life of Robert Browning* (Everyman's Library Edition), p. 27.

[4] Pp. 221–248 (New York, 1897).

that the intellect without the affections is a vain guide in life" The words love and knowledge, he says, are used, both in *Paracelsus* and in the poet's later works, "in a pregnant sense" In an analysis of the character of Paracelsus, which lays great stress on Browning's fidelity to his sources, Professor Royce classifies the hero of the poem as an "empirical mystic," who, in order to confirm his higher intuitions, strives to find in the outward facts of the physical world a revelation of the ultimate meaning of the universe Aprile, on the other hand, is a poet, who seeks in the inner shrine of the heart an unfolding of God's purposes and the clue to the mystery of life It is the divergence in the types represented by the two men and, above all, the difference between the places where they have sought for a manifestation of the divine order, that Royce regards as disclosing the sense in which Browning uses the terms 'knowing' and 'loving'

"The antithesis between 'knowledge,' as the occultist conceives it, and 'love,' as the poet views it, is the contrast between looking in the world of outer nature for a symbolic revelation of God, and looking in the moral world, the world of ideals, of volition, of freedom, of hope, and of human passion, for the direct incarnation of the loving and the living God"

In support of this view Professor Royce refers to the fact that in *Reverie* and other poems, Browning makes a similar distinction between knowledge and love "Mind in survey of things," according to Browning, 'discerns in the external order of the universe the existence of 'power,' but no clear evidence of a moral purpose at work But in the inner world and in those human relationships where the intuitions of the heart have free scope, the goodness and providence of God are apprehended as a manifestation of love revealed to the seeker after love

That Browning does frequently link the perception of power in the outward order of the universe with knowledge, and seek for a revelation of the moral qualities of God in love as a divinely inspired virtue animating the soul of man, is indisputable Nor can it be doubted that this particular antithesis between the spheres of knowledge and love enters as an element into *Paracelsus* It is, however, I believe, strictly a subordinate ele-

ment It does not, for one thing, explain the failure of Aprile Nor does it take into account the striking differences between the conception of love in the second and in the fifth division of the poem Throughout his article, Professor Royce, as it seems to me, has overstressed Browning's faithfulness to the exact type of character represented by the historical Paracelsus On the other hand he has not given sufficient weight to more immediate sources of inspiration connected with the poet's relationship to the Romantic Movement, and the artistic and ethical qualities of his genius [5]

An investigation of any of the leading ideas of *Paracelsus* must begin with the recognition of the essential connection in theme and spirit between *Pauline*, *Paracelsus*, and *Sordello*, published in the years, 1833, 1835, and 1840, respectively All of these poems are occupied with character, as exhibited in thought, feeling and motive, rather than in outward event Though there is a certain gradation in the degree of their subjectivity, historical environment and circumstance are everywhere subordinate in these three works to "the incidents in the development of a soul," depicted as they arise within the inner world of man's spiritual being Moreover, as has been noted by various critics, the characters delineated in this group of poems are of the same general type They are all endowed with the infinite aspiration and towering ambitions of genius, and their problem lies in the difficulty of reconciling the inexhaustible demands and cravings of the spirit with the finite conditions and

[5] For a careful consideration of the weight to be attached to the historical element in *Paracelsus*, see pp 65–72, in *The Life of Robert Browning*, by W H Griffin (London, 1910) The following citations represent the conclusions reached in this biography regarding the point in question

"The extreme erudition of Browning's notes (i e in *Paracelsus*) is often more apparent than real"

"The so called sources of his poem are practically contained in a few pages of Bitiskius, sundry passages in the works of Paracelsus himself, and in that interesting little octavo of 1620, the *Vitae Germanorum Medicorum* of Melchior Adam. But the most important source of all is Robert Browning."

"The record of aspiration, defeat and attainment — all that really constitutes the spiritual history of the poem — is of Browning's creation, it is his 'commentary'"

limitations of life The dramatic tension of this conflict is portrayed in *Pauline*, *Paracelsus*, and *Sordello*, as giving rise to successive experiences of aspiration and failure followed by renewed striving Through the fluctuation of these spiritual vicissitudes the deeper meaning of life is gradually discerned "All poetry," Browning once wrote to Ruskin, "is the problem of putting the infinite into the finite" It is this problem, in the sphere of life, that is the crux of the three studies in the development of a soul, which constitute the most significant work of Browning in the early stages of his poetical career In keeping with the genius of a poet who has taken

> *for a worthier stage the soul itself,*
> Its shifting fancies and celestial lights,

the approach to the study of *Paracelsus* must be made from within rather than from without That is to say, the interpretation of the dominant ideas of the poem must be sought through their connection with Browning's own individuality and the artistic and ethical influences formative of the spirit of his poetry, rather than in an ostensible machinery of historical event

There are two characteristic attitudes of Browning's mind, or, perhaps it might be said, dispositions of his spirit, which are constantly reflected in his poems

A deep conviction of the infinite potentialities of the soul, its transcendental origin and immortal destiny, is a primary element in his self-consciousness Linked with this is a belief that the purpose of life is a continuous striving to surpass the limitations imposed upon the soul by the finite conditions of time and sense

> Life is — to wake not sleep,
> Rise and not rest, but press
> From earth's level where blindly creep
> Things perfected, more or less,
> To the heaven's height, far and steep [6]

The source of Browning's perception of the inexhaustible capacities of the soul lies in part in the prodigality of his own intellectual and spiritual powers It also has its roots in the

[6] *Reverie.*

romantic traditions and enthusiasms he inherited from that group of English poets, whose works are aglow with the hopes and impulses of the revolutionary epoch Browning, as has been said, "carried with him something of Byron's energy, of Keat's artistic skill, and of Shelley's ideal passion, and Wordsworth's transcendentalism, into the orderly, scientific age which succeeded the romantic period "[7] In particular, the torch of Browning's poetic inspiration was kindled from the pure and luminous flame of Shelley's etherial genius In the soaring aspiration and spiritual ardor of Shelley, his thirst for the infinite, his quest of an ideal beauty, his ceaseless endeavor to transcend the finite barriers of life, are winged seeds of thought and emotion which bear fruit in the imagination of Browning

But while the mood of romantic aspiration and an intense consciousness of the boundlessness of personality enter vitally into Browning's poetry, there is a complementary truth which has an important place in his view of life and is an equally significant element in his thought The world to Browning, as to Keats, is "the vale of Soul-making," and, in this moulding of souls, the finite as well as the infinite has a positive part to play The limitations imposed on man by the imperfect conditions of his earthly existence are a school of discipline intended to serve the end of spiritual growth To refuse to use the instrumentalities of life, faulty though these may be, and to disregard its laws, is to scorn the means through which the spirit is nourished and enabled to elicit the divinity that lies within it To attempt to overleap the finite or neglect the claims of the material and temporal realities of life, is to evade life's test and to fall into the error of spiritual abstraction While placing the goal beyond all limited accomplishment, the soul must learn to make a fruitful use of the means and possibilities of man's earthly lot Thus, while, from one point of view, life must be an unceasing aspiration in pursuit of an infinite ideal, from another it must be a continuous stooping to a world of weakness and finitude

[7] Cited from an article on Robert Browning in *Littell's Living Age*, June, 1890.

A perception of this latter truth, with its corresponding attitude of a wise acceptance of the working conditions and restricted powers of life, is the counterpoise to that mood of passionate aspiration and unfettered idealism, spurning the clogs of sense, wherein Browning is confessedly the inheritor of the mantle of Shelley and his fellow romanticists The sources of the second disposition of Browning's thought and feeling, where he parts company with Shelley, lie, in a measure, in certain robust elements, both physical and psychical, in his nature Bodily vigor, with its accompaniment of a rich sensory organization, made him appreciate "the value and significance of flesh" and gave him a firm grip on the concrete and tangible, as opposed to anything partaking of the character of spiritual asceticism This physical tendency is reënforced by intellectual and emotional qualities In Browning's minute observation, his delight in subtle analysis, his keen perception of the manifoldness of life and the distinctness of its various forms, he manifests, even in the service of ideal ends, an individualizing temperament akin in method if not in aim to the critical and scientific realism of his day

But Browning's recognition of the necessity of stooping to the finite must also be attributed in large part to his religious consciousness, particularly his appreciation of the fundamental truth revealed through the Christian doctrine of the Incarnation This is especially apparent in the way he stresses the natural and human, as well as the mystic and divine aspect of personality

The two dispositions of Browning's inner being prevent him from attempting to cut the Gordian knot of life's mystery by ignoring its complexity, or by doing violence to the integrity of personality by overlooking one of its dual elements The incidents in the development of a soul, with which he is essentially concerned, centre about the paradox that man is a being in whom the claims and purposes of the finite and infinite, body and soul, flesh and spirit, time and eternity, meet and must each receive due recognition

While the interplay between the two habitual attitudes of Browning's spirit may be traced throughout his poetry, it is especially pivotal in *Pauline*, *Paracelsus*, and *Sordello* The heroes

of these poems are unmistakably of the romantic type They are all characterized by a restless and eager self-consciousness, unsatisfied longings, infinite desires, an unmeasured hunger for perfection, that impel them to press on beyond the limits of the finite In their indomitable aspiration, lofty idealism, and unclouded vision of absolute spiritual values, they represent the incarnation of romantic traditions and impulses, which are an elemental part of Browning's own genius

But Browning, like Goethe, was able from the standpoint of a dual consciousness to overlook and diagnose the perils of romanticism, even while it struck responsive chords within his being Throughout *Pauline*, *Paracelsus*, and *Sordello*, he has probed with an unsparing hand the cancer of romantic egoism, with its passionate, unbridled impulses of limitless self-assertion, its scorn of all relative accomplishment, and its tendency to seek refuge in vague abstractions It is a disdain for the finite, a refusal to stoop to the necessary conditions of life, a negation of the actual rather than the ideal side of man's nature, that constitute the fallacy and account for the imperfect insight of these gifted though tempest-tossed men of genius, — children of the heaven-storming Titans —, whom Browning has so vividly depicted in his earlier poetry

Such being the general setting of *Paracelsus*, I proceed to a discussion of Browning's conception of love, as set forth in the second and fifth divisions of the poem

In the second canto of *Paracelsus*, love is revealed as embodied in the person and ideals of the poet Aprile Here, as Professor Royce has pointed out, the fact that Aprile has the artist's vision of beauty and seeks a manifestation of the divine import of life in the world of human emotions, enters into Browning's thought in regarding him as an embodiment of the principle of love Yet Aprile is not merely a poet, but a particular type of poet, and represents very definite impulses and sympathies in Browning's nature In no part of *Paracelsus* is Browning's kinship with that early nineteenth century group of English romanticists, of whom Shelley may be considered an outstanding representative, more strikingly apparent than in the episode of the

meeting between the Renaissance scholar and the Italian artist in the house of the Greek conjurer at Constantinople The very creation of Aprile is undoubtedly to be traced to the influence of the personality and writings of Shelley upon Browning Just to what extent the latter was indebted to certain elements in *Prometheus Unbound*, *Alastor*, and *Adonais*, for the suggestion of the character of Aprile, must be a matter of conjecture But it seems unmistakable that he had Shelley vividly in mind in his portraiture of the spiritually impassioned seeker after absolute beauty, "who would love infinitely and be loved" The limitless aim, the eager craving after emotional experience, the exquisite sensitiveness, the single-hearted impulsiveness of Shelley, are reflected in Aprile Shelley, like Aprile, eagle-winged in aspiration, had been dazzled by a vision of the infinite, and his lofty conception of love remaining merely nebulous, too often tended to dissipate itself in dreams and abstractions

The genesis of Aprile is indicative of the type of love embodied in his person and utterances throughout the second canto of *Paracelsus* It is, as a matter of fact, one form of that ideal of romantic love, for the notion of which Browning is primarily indebted to Shelley and to Shelley's spiritual master, Plato It was inevitable, in view of his literary traditions, that Browning should be profoundly affected by that great conception of love, which has played so important a rôle in English poetry In *Pauline*, Browning's first printed work, Shelley and Plato are apostrophized as the teachers and seers who have moulded the thought and captivated the imagination of the youthful hero The influence of Plato's view of love, as enunciated in the *Symposium* and *Phaedrus*, might be illustrated from a large number of Browning's poems Such a love lyric as *Cristina* is based on a belief in reminiscence and the transcendental nature of love, ideas steeped in Platonic mysticism Again, in *Easter Day*, the ascension of the soul above the sphere of finite existence to a divine love, is in harmony with Plato's notion of man's quest of a perfect and eternal archetypal loveliness, but dimly foreshadowed in the perishable forms of earth This view of love is in keeping with the first of the two characteristic dispositions of Browning's mind

and heart previously referred to, the spirit of romantic ardor and illimitable aspiration, which is so significant an element in his genius

The fine opening passages of the second canto of *Paracelsus*, where Aprile reveals his "mighty aim" and "full desire," portray love in the loftiest vein of romantic idealism The love of the poet Aprile might be defined in the very words of Plato as "the desire of generation and production in the beautiful" Aprile would woo the loveliness of life through the medium of the creative genius of the artist He yearns to reveal and transfigure the beauty of the natural world by reclothing it in the glorious forms of art Thus his works would remain in the sight of all men, as pledges of the love which existed between himself and the beautiful But, desiring to grasp the whole sum and absolute essence of beauty, he cannot rest content with any finite manifestation of it From art to art Aprile's vision of love leads him on in ecstatic contemplation of a bewildering wealth of beautiful forms [8]

The way in which the love of Aprile rises from the material to the spiritual, and from the finite to the infinite, is illustrated by the order in which the various artistic forms become the object of his desire He begins with sculpture, the most essentially imitative of the arts the art that clings closest to earth From sculpture he passes to painting, art in two dimensions, the more imaginative and less material of the spacial arts But, having reached this stage, Aprile would "throw down the pencil as the chisel" and ascend to the more spiritual region of poetry Finally, "to perfect and consummate all," he rises above poetry to the sphere of music, the most subtle and least corporeal of the arts

[8] Cf Plato's *Symposium* (Shelley's translation) "He who aspires to love rightly ought from his earliest youth to seek an intercourse with beautiful forms, and first to make a single form the object of his love He ought then to consider that beauty in whatever form it resides is the brother of that beauty which subsists in another form, and if he ought to pursue that which is beautiful in form it would be absurd to imagine that beauty is not one and the same thing in all forms, and would therefore remit much of his ardent preference towards one, through his perception of the multitude of claims upon his love"

Music to Browning is always a symbol of the infinite, the art which, above every other, is typical of the aspiration of the soul towards the spiritual, eternal and divine Thus the hero in *Pauline* speaks of

> Music which is earnest of a heaven
> Seeing we know emotions strange by it,
> Not else to be revealed

So, in *Paracelsus*, "even as a luminous haze links star to star," Aprile would

> supply all chasms with music,
> Breathing mysterious notions of the soul, no way
> To be defined save in strange melodies [9]

Yet love cannot rest even here The sum of earthly beauty is unable to satisfy it In God alone does the divine craving of love, the deepest impulse of the soul, find the adequate object of its desire So Aprile, having striven, in fancy, to embrace the whole universe of finite beauty through the mediation of all the arts, longs at length to pass beyond this, and to dwell in mystic intercommunion with the perfect love of God

> I have gone through
> The loveliness of life, create for me
> If not for men, or take me to thyself,
> Eternal, infinite love [10]

Few poets have represented love in its romantic and transcendental aspect so superbly as Browning His perception of the insurgent vehemence and boundless vision of love, as a supreme spiritual principle, blends in repeatedly with his conviction of the ceaseless progress towards an infinite ideal The poet's treatment of love from this point of view has received general recognition "Of all the passions," writes Professor Alexander, in his summary of Browning's philosophy, "none so reaches out towards the infinite as love For Browning, then, as well as Plato, love both symbolizes and arouses that thirst for the infinite which is

[9] *Paracelsus*, Part II
[10] *Paracelsus*, Part III

the primary need of humanity There is something mystical and transcendental in the power of love " [11]

In a similar vein Professor Herford says " Browning as the poet of Love is thus the last, and assuredly not the least, in the line which handed on the torch of Plato The author of the *Phaedrus* saw in the ecstasy of Love one of the avenues to the knowledge of the things that indeed are To Dante the supreme realities were mirrored in the eyes of Beatrice For Shelley Love was interwoven through all the mazes of Being, it was the source of the strength by which man masters his gods To all these masters of idealism Browning's vision of love owed something of its intensity and of its range " [12]

But while the portrayal of love as a mystic, transcendental, and romantic passion, is very frequent in Browning, does it embrace his complete view of the nature of love, particularly as set forth in the poem of *Paracelsus*? Through the self-revelation of Aprile, Paracelsus realizes his fatal mistake in leaving love out of his scheme of life

> I learned my own deep error, love's undoing
> Taught me the worth of love in man's estate [13]

Is it, however, a failure to grasp the specific conception or aspect of love represented in the aims of Aprile, that is the fundamental error of Paracelsus?

A comparative study of Browning's delineation of Paracelsus and Aprile forces home the conviction that, despite the distinction between the objects of their pursuit, the resemblances between them are more basic than the differences Though the one seeks knowledge, the other love as revealed through beauty, both are idealists and transcendentalists, with a thirst for the absolute, an unquenchable desire to surpass all finite limitations, a vision of perfection which forbids them to rest content with any finite attainment As Paracelsus aspires and fails, so Aprile aspires and fails To preserve the formal identification of the characters with

[11] W F Alexander, *An Introduction to the Poetry of Robert Browning*, (Boston, 1899), p 54

[12] C H Herford, *Robert Browning* (London, 1905), p 308.

[13] *Paracelsus*, Part V

the principles of knowledge and love, Browning, in places, attributes the failure of Aprile to a neglect of knowledge But, in reality, Aprile's example is a warning to Paracelsus because there is an underlying similarity in their aspiration and failure In common with Paracelsus and Sordello, Aprile is perplexed and baffled through his incapacity to "fit to the finite his infinity" Wishing to possess all, "to thrust in time eternity's concern," he clings to the bare form of the infinite and loses himself in dreams and abstractions If he strives to break the spell that binds him and to single out one individual shape of loveliness, "and to give that one entire in beauty to the world," immediately other shapes come crowding thick upon him, and his will is paralyzed

> And did not mist like influences, thick films,
> Faint memories of the rest that charmed so long
> Thine eyes, float fast, confuse thee, bear thee off,
> As whirling snowdrifts blind a man who treads
> A mountain ridge, with guiding spear, through storms? [14]

An unwillingness to subdue his nature to the conditions imposed by life, or to work out his destiny in and through the necessarily imperfect circumstances of his earthly lot, is recognized by Aprile as the source of his downfall

> Knowing ourselves, our world, our task so great,
> Our time so brief, 'tis clear if we refuse
> The means so limited, the tools so rude
> To execute our purpose, life will fleet,
> And we shall fade, and leave our task undone [15]

The failure of Aprile is, in itself, an indication that Browning has not set forth his full conception of the nature of love in the second canto of *Paracelsus* Apart from teaching the general worth of love, it is difficult to see how such a type of love, as is represented in the person and quest of Aprile, could have proved the salvation of the Renaissance hero of Browning's poem The errors of Paracelsus are those of a transcendentalist and idealist blinded by a vision of the absolute, refusing to stoop to the weakness and finitude of life Yet it is precisely the romantic

[14] *Paracelsus*, Part II.
[15] *Paracelsus*, Part II.

and transcendental characteristics of love, regarded as the unceasing pursuit of an ideal of perfection and an infinite spiritual aspiration, that are embodied in the poetical imaginings of Aprile Such a portrayal of love is in keeping with the romantic origins of the figure of Aprile, and an expression of that side of Browning's genius which is in sympathy with the impulses and traditions of romanticism Since, however, it presents an aspect of love that is akin in spirit to the uncompromising idealism, passion for the absolute, and soaring aspiration of Paracelsus, it cannot, except by a *tour de force*, be regarded as supplying a corrective for the error of that character While Browning makes a general distinction between knowledge as the aim of the Renaissance scholar and love as the artist's passion for the beautiful, the contrast between Paracelsus and Aprile is not consistently maintained in the details of the two opening cantos of the poem It is hard to escape the conviction that Aprile fails, not from a lack of knowledge, but because he, like Paracelsus, has spurned the finite conditions of life

It seems, therefore, unmistakable that Browning's portrayal of love in the spirit of romantic idealism, in the second part of *Paracelsus*, involves the poem up to this point in a measure of self-contradiction If the presentation of love throughout *Paracelsus* must be considered as all of one piece, the difficulty extends itself to the entire work

It is, however, not in the second, but in the fifth canto of the poem, that Paracelsus realizes most fully the causes of his failure, and obtains his deepest insight into the nature of love A comparison between Browning's treatment of love in these two parts of the narrative is illuminating In the last words of the dying Paracelsus, love is conceived of in a way that cannot be regarded as a mere reiteration or enforcement of that romantic ideal of love embodied in the impassioned reveries of Aprile The fact is that Browning's representation of love, both in *Paracelsus* and other poems, is a complex one As Browning portrays love with all the energies of his being, and the full resources of his genius, it is inevitable that love should be in his poetry a highly organized and manifold concept In particular, it reflects the two funda-

mental dispositions of his spirit already alluded to, and the artistic and religious influences entering into his life and work The counterpart of Browning's mood of aspiration, as has been noted, is his recognition of the necessity of stooping, in the spirit of humility and self-sacrifice, to the finite limitations of life The sources of this disposition lie largely in Browning's profound appreciation of the central truths of the Christian faith

Consequently, Browning has given in the final canto of *Paracelsus,* not a romantic or Platonic, but a Christian representation of love

Such a delineation of love is indeed foreshadowed in Aprile's confession of his failure at the close of the second part of the poem Could he live again, he tells Paracelsus, he would not spurn the finite or reject the imperfect means at his disposal Rather he would strive to give some partial representation of beauty to the world, even though this were but a fragment or a trifle, "one strain of all the psalm of the angels," as a pledge of the infinitude of beauty beyond While still inspired by a consciousness of an ultimate goal of perfection, he would be content to achieve on earth a portion of that infinite good, which should be a prophecy of the whole Aprile's final desire is to unite himself and his art with common life, and to set this forth in beauteous hues Such a willingness to work within the bounds allotted to humanity, he perceives, is not inconsistent with the highest aspiration To stoop to the weakness and lowliness of his brother men would not, as he mistakenly had thought, involve a sacrifice of his divine calling His would be the self-same spirit, but "clothed in humbler guise"

> As one spring wind unbinds the mountain snow
> And comforts violets in their hermitage [18]

That Browning is here representing Aprile's error as due to a failure to grasp that conception of love which may be regarded as preëminently Christian, is made explicit in lines added by the poet, in one edition of *Paracelsus*, at the end of Aprile's dying speech

[18] *Paracelsus*, Part II.

Man's weakness is his glory — for the strength
Which raises him to heaven and near God's self
Came spite of it. God's strength his glory is,
For thence came with our weakness sympathy,
Which brought God down to earth, a man like us![17]

The final attainment of Paracelsus, as portrayed in the fifth canto, is an expansion of the idea of love set forth in these lines. It is a description of love which, without direct Christian reference, is permeated by Browning's religious sympathies. Love is here, not a romantic passion for a transcendent ideal of absolute beauty, but a divine condescension to human imperfection, and a tender compassion for mortal frailty. Love stoops to conquer, triumphs in the midst of conflict and suffering, and wins its way from weakness to strength. Such a love breaks down the overweening pride of Paracelsus, his self-sufficient individualism, his scorn of the limitations of life, and unites him in bonds of sympathy with his brother men. In the light of this vision of love he realizes the cause of his failure.

In my own heart love had not been made wise
To trace love's faint beginnings in mankind,
To know even hate is but a mask of love's,
To see a good in evil, and a hope
In ill-success, to sympathize, be proud
Of their half-reasons, faint aspirings, dim
Struggles for truth, their poorest fallacies,
Their prejudice and fears and cares and doubts,
All with a touch of nobleness, despite
Their error, upward tending all though weak,
Like plants in mines which never saw the sun,
But dream of him, and guess where he may be,
And do their best to climb and get to him.
All this I knew not, and I failed.[18]

Love teaches Paracelsus no longer to despise the past, or to close his eyes to God's plan of a gradual evolution and progressive unfolding of the divine purpose from age to age. In his previous disregard of these truths Paracelsus may be said to prefigure that lack of sympathy with human weakness, and that abstract ideal-

[17] *Paracelsus*, Part II (omitted in later editions).
[18] *Paracelsus*, Part V.

ism, so typical of the revolutionary and romantic epoch at the dawn of the nineteenth century

> I saw no use in the past, only a scene
> Of degradation, ugliness and tears,
> The record of disgraces best forgotten,
> A sullen page in human chronicles
> Fit to erase I saw no cause why man
> Should not stand all-sufficient even now,
>
> I would have had one day, one moment's space,
> Change man's condition, push each slumbering claim
> Of mastery o'er the elemental world
> At once to full maturity [19]

Through his deeper insight into the character of love, Paracelsus discerns it as an immanent principle dwelling even in "life's minute beginnings," and incarnating itself at every stage of the evolutionary process Viewed in the light of love, the struggles and imperfections of the past are fraught with value and significance and consecrated by human endeavor

> Not so dear child
> Of after days, wilt thou reject the past
> nor yet on thee
> Shall burst the future, as successive zones
> Of several wonder open on some spirit
> Flying secure and glad from heaven to heaven
> But thou shalt painfully attain to joy,
> While hope and fear and love shall keep thee man [20]

Thus the poem of *Paracelsus* closes, not with Aprile's resplendent vision of "eternal, infinite love," but rather with love in its humblest manifestations, "human at the red-ripe of the heart"

> Love — not serenely pure
> But strong from weakness, like a chance-sown plant,
> Which cast on stubborn soil, puts forth changed buds
> And softer stains unknown in happier climes,
> Love which endures and doubts and is oppressed
> And cherished, suffering much and much sustained,

---

[19] *Paracelsus*, Part V
[20] *Paracelsus*, Part V

And blind, oft-failing, yet believing love,
A half enlightened, often chequered trust

Love still too straitened in his present means,
And earnest for new power to set love free [21]

To sum up the conclusions derived from a study of Browning's *Paracelsus,* it seems evident that a complex rather than a single and uniform conception of love is involved

In the second canto, love, typified in the person and ambitions of the artist Aprile, is depicted in its romantic aspect, as a struggle to reach heights unattainable on earth Love is revealed as a principle of infinite aspiration involving the pursuit of an ideal of perfection Such a portrayal of love is in harmony with the Shelleyan origins of the character of Aprile, and is a reflection of Browning's own romantic traditions and sympathies It is also in keeping with Browning's innate transcendentalism, and his perception of the inexhaustible energies and unlimited scope of personality

While the conception of love in the fifth division of *Paracelsus* is complementary rather than antithetical to that set forth in the second canto, it cannot be regarded as of identical character In the words of the dying Paracelsus, love is represented from another point of view, as a principle of self-surrender and a strength that stoops to weakness Love is conceived of here, not as a transcendent aspiration, but as a condescension of the divine to the human, and a wise acceptance of the limited means and opportunities of life As opposed to the emptiness of an abstract intellectual ideal, love binds together the claims of the spirit and the flesh and "shows a heart within blood-tinctured of a veined humanity" Such a portrayal of love is an expression of the spirit of Christian *Magnificat,* rather than of romantic or Platonic idealism, and it manifestly has its sources in Browning's deep religious convictions, above all his appreciation of the supreme truth revealed through the doctrine of the Incarnation

Since love is the richest and most highly organized concept in Browning's poetry, the twofold strand in his delineation of it

[21] *Paracelsus,* Part V

is, as I have stated, a natural consequence of the two fundamental attitudes of his soul those of aspiration towards the ideal and of stooping to the real These provinces of Browning's feeling are in large part rooted in the two great moulding influences that enter into his life and poetry, his artistic inheritance of the traditions of English Romanticism, and his religious legacy of the spirit and tenets of evangelical Christianity

While the romantic elements in Browning's treatment of love have been very generally recognized, a like stress has not been placed on that aspect of his conception of love which is represented in the fifth part of *Paracelsus* Yet it might readily be shown, by reference to a large number of Browning's poems, that his delineation of love from this point of view is as vital and characteristic as his portrayal of it in the spirit of romantic idealism To select a single example among many, the beautiful love lyrics placed at the end of each parable in *Ferishtah's Fancies*, all centre about love as manifested in its preeminently human aspect It is the thought of love stooping to finite imperfection, "not serenely pure, but strong from weakness," love refusing to spurn the body or despise the world in the interests of an ascetic ideal of spirituality, that forms the chorded refrain of these exquisite snatches

In particular this conception of love is intimately related with Browning's perception of its supreme revelation in the person of Christ "Such ever was love's way to rise it stoops," is the characterization of the nature of love Browning places on the lips of St John in *A Death in the Desert*, — and in *Saul* and *An Epistle of Karshish*, the Incarnation is represented as the Divine Love that for man's sake became poor and of low estate

> 'Tis the weakness in strength that I cry for!
>   my flesh that I seek
> In the Godhead![22]
>
> The very God! think Abib, dost thou think?
> So, the All-Great, were the All-Loving too —
> So, through the thunder comes a human voice
> Saying, "O heart I made, a heart beats here!

[22] *Saul*.

Face, my hands fashioned, see it in myself!
Thou hast no power nor mayst conceive of mine,
But love I gave thee, with myself to love,
And thou must love me who have died for thee!'"[23]

[23] *An Epistle of Karshish*

UNIVERSITY OF MICHIGAN

ASSYRIAN MEDICINE IN THE SEVENTH CENTURY B C

LEROY WATERMAN

THE British Museum alone possesses six hundred and sixty-six cuneiform medical texts In 1902, Friedrich Küchler published and interpreted the first of these as a doctor's thesis and in 1904 issued his further studies of these texts in his larger work *Beitrage zur Kenntniss der Assyrisch-Babylonischen Medicin* For fifteen years R Campbell Thompson of Oxford has been engaged upon the task of interpreting the entire corpus of the British Museum's great Medical Series The advance sections of this publication are only recently announced from the press [1]

The present paper makes no claim to deal with this class of material On the contrary it will be confined entirely to certain data on the practice of medicine as it is found incidentally in the *Royal Correspondence of the Assyrian Empire* [2] The material includes fourteen hundred and seventy-one texts and fragments and covers the period from 722 B C to the fall of Nineveh 608 B C

With magic and incantation ceremonies playing a large rôle in the practice of medicine within comparatively recent times, we shall not be surprised to find these factors at work in the same field 2500 years ago It will be our task to point out how much opportunity these elements do, nevertheless, allow for the exercise of common sense and the beginning of a scientific tradition in medicine

The development in Assyria, mainly during the seventh century B C, of a very extensive official class very naturally included

[1] *Proceedings of the Royal Society of Medicine*, 17 (1924) 1–34

[2] *University of Michigan Studies, Humanistic Series*, Vols XVII–XX (in preparation)

court physicians The trying climate of the Tigris-Euphrates valley, especially in summer, gave every incentive to exercise the healing art Add to this the fact that from Esarhaddon (680 B C) onward, the Royal House of Assyria began to show marked symptons of physical degeneracy and an easy, if not alarming, susceptibility to disease, and it will be readily understood why the practice of medicine plays a somewhat conspicuous rôle in the records of the seventh century B C

We know the names of many of these physicians and we possess letters from a considerable number of them written, for the most part, to the king The greatest number from any one of them totals at least thirty-six, the next highest about a dozen, and so on These texts are by no means confined to medicinal matters, but have the most varied human interests, and from them we incidentally learn that a physician was apt to be a priest as well, also an astrologer, with which function were associated certain definite observations of the heavenly bodies, which entitled him, furthermore, to be called an astronomer Besides this it was usually the case that he was known as a magician It is not possible to say from our sources that every physician exercised all these other functions, but the evidence favors the conclusion that no one of these activities was the sole accomplishment of a single individual, but rather that at least two of them always went together in this period, and certainly in the case of those best known to us, we are obliged to add yet another function, viz , that of diplomat or politician

The esteem in which physicians were held and the degree of reliance put upon them in the period under observation, not only by the court but by the official classes generally, may be seen from the most casual references Shamashmituballit, one of the sons of Esarhaddon, writes thus to his father [3] "To the king my lord thy servant Shamashmituballit, may it be well with the king my lord May the Gods Nabu and Marduk be surpassingly gracious to the king my lord Now the handmaid of the king Baugamelat, is exceedingly ill She cannot take nourishment Now let the king my lord give a command and let a physician

[3] Harper's *Assyrian and Babylonian Letters*, No 341

come and see her" In a broken letter [4] from which the writer's name is missing, we read as follows "And regarding that which the king my lord has written, saying 'In lieu of Radmanu's report there is word from the city of Sippar that (so and so) is sick, that he sends to you, saying "Is there not a Babylonian (physician) whom you can send"'" And again Adadshumusur, the physician from whom we have the most documents, writes thus to the king to clear himself of seeming negligence [5] "In regard to the two men who are in the new house and in regard to Siupirhiukin, of whom the king my lord has written, saying 'Go (and) visit them,' now the king my lord knows that the chief officer has brought me to the house of Dani on behalf of his son I am attending him His malady is serious, he is exceedingly ill In view of the fact that I am occupied with him, it is not feasible for me to set out today I shall go in the morning and examine them and report their condition to the king" He goes on to add as a further precaution "I shall appoint the Mashmash priests They will perform their ritual," i e, for the sick Here the use of magic and the aid of religion are acknowledged, and while the writer was himself a priest and high conjurer, still, because of increased demands upon him as a physician, there seems to have been a tendency to specialize primarily as a physician and thus to sharpen the cleavage between medicine and other means of healing

The value of the principle involved in a council of physicians was also recognized in Assyria, although naturally under a despotism it might be expected to take a less democratic form than with us In fact the king might be the only person who knew that such a principle had been invoked, as another letter from the Adadshumusur mentioned above will illustrate The circumstances were that the crown prince, probably Ashurbanipal, had become ill, a physician had been consulted, and a prescription had been prepared for the making of a potion The king had received it and given orders to have it filled, and before this had been accomplished, he bethought himself that it might be worth while to get the counter-advice of another practitioner,

[4] Letter No 608 [5] Letter No 1

whereupon he wrote a letter to Adadshumusur about it, and we have the reply of that individual. This reply brings out clearly the politic and diplomatic character of this man and it also contains advice that might possibly be applied with salutary effects today, although it would doubtless tend to make the profession of medicine less popular than it is at present. After the usual greeting he writes:[6] "In regard to the making of the potion of which the king my lord has written, it is especially fitting, as the king my lord has commanded those servants. We shall make haste to have them drink (of it first), thereafter let the crown prince drink (of it). But what am I saying! I am an old man who has lost his reason! That which the king my lord has spoken is as final as the word of a god."

One of the most persistent and wearing diseases of the valley of the two rivers was malaria, and accordingly we hear much of fever and ague in the Assyrian letters. In a broken text Mardukshakinshum writes to Esarhaddon:[7] "In regard to the fever ... of which the king my lord (has written) I am one who releases ... let me come to the king my lord." He then mentions, in a broken context, ceremonies pertaining to the fever which he would be glad to perform, and closes with the assurance that the great gods Bel and Nabu will lay their quickening hands on the king his lord. The same Adadshumusur reports to King Esarhaddon about the case of one of his delicate sons, Ashuretilshameuirsitiballitsu. "It is well with Ashuretilshameuirsitiballitsu. His fever is broken. There is no sin involved."[8]

Another letter from Mardukshakinshum shows that Esarhaddon was subject to malaria, the body of the letter runs thus:[9] "In regard to the ague of which the king my lord has written, there is no sin. The gods of the king will quickly grant release." Farther on he mentions the sickness of Royalty in a way that leaves little doubt that it is the king's own illness that is concerned.

Diseases of the eye and ear evidently claimed their victims,

[6] Letter No. 3.
[7] Letter No. 664.
[8] Letter No. 658.
[9] Letter No. 663.

much as is the case in the east today, and there are indications that Royalty sometimes went out of its way to interest itself in trying to relieve such cases Such seems to be the purport of a letter [10] to the king written by the physician Arad-Nana After the usual greetings he reports "It is well indeed with this unfortunate man whose eyes are diseased I had put a dressing on them that covered his face Yesterday toward evening, the bandage which held it on I removed I took off the dressing that was there There was pus the size of the tip of the little finger " The writer then modestly veils his manifest elation at the successful treatment, when he adds 'Whoever of thy gods has put his hand to this case, has himself surely given his orders explicitly It is extremely favorable In seven or eight days he should be (entirely) restored "

In the following letter [11] both the writer and the recipient are unknown, but it is clearly by a physician to the king After a greeting which invokes the blessing of Ninib and Gula, noted deities of healing, he says " Regarding the healing of the ears which I have undertaken, everything is done Yesterday the king did not lift up his head Now today let him do it " In the broken context that follows there are references to prescriptions and other physicians

The test of sincerity in the healing art as well as the measure of self-confidence that the physician, at least, thinks he knows what he is doing, is often revealed by the process of diagnosis That is to say, an overemphatic assumption of ability to understand and heal anything may have a psychological as well as a commercial value, but even in our own day may well raise doubts at times, and perhaps this was true in an earlier day when medicine was more dependent on magic At any rate, the frankness of the Assyrian doctors seems commendable For example we have a reply by Mardukshakinshum to a first aid call, so to speak, from the palace of Esarhaddon, backed up by royal orders He says [12] " In regard to the poultice of licorice of which the king my lord has spoken saying 'The burning is unendurable, tell us quickly what shall we do'" The nature of this summons

[10] No. 392 [11] No 465 [12] No 19

has every indication of being dictated over the king's signature by perhaps some anxious mother of the royal harem concerning a tender offspring, and from the physician's reply we should judge that the youngster was suffering from an ailment about as severe as colic, for the letter continues "The burning (reported) is not a real burning and as a remedy for it let them make a cold application," and he goes on to add "Now I do not understand why he has had this attack This report itself does not harmonize the one part with the other" And having made confession, he frankly and decently takes refuge in religion by adding "The gods have done it"

There were cases, however, where the royal appeal might become an insistence that was serious if not menacing, as the following letter from Arad-Nana [13] will show "Repeatedly the king my lord keeps saying 'Wherefore do you not perceive the nature of this sickness of mine Are you not going to accomplish its healing?' Earlier I spoke in the king's presence 'I do not understand his affliction' Now I have just sealed a letter and sent it off May they read it to the king and may they make it clear to the king my lord If it is acceptable before the king my lord let a conjurer perform the rites pertaining thereto This bathing of the king let them perform Directly this fever will pass away from the king my lord This lotion of oils should be applied to the king two or three times The king understands it If the king commands it, in the morning let them do it There is infection also in the pus, and the sweet root, which they bring before the king, as they have done twice already, let them rub on vigorously I shall surely come and give instructions Directly the strength of the king will revive Unto its full tide I shall bring it back to the king my lord Let the king put on his throat the ointment I shall bring On the appointed day let the king be anointed"

Sometimes a court physician seems a trifle too anxious about the health of his royal charge and diagnoses accordingly Such an instance may be found in a case where it has evidently been reported to Adadshumusur that the king is inclined to fast and

[13] No. 391.

he feels that he should be properly advised [14] "Wherefore is not meat served before the king a second time this day? Whoever laments for Shanash, the king of the Gods, laments a day and a night and two days additional The king of the lands my lord is the very image of Shanash, is it only one half day thou art sad, even that sadness is not good for the mind It is like the day of death fasting, neither eating nor drinking, confuses the understanding It brings on sickness Thus it is Let the king hearken to his servant"

The examples of prescriptions for ailments in these documents reveal the fact that nearly all the attitudes taken in modern times in combating disease were represented 2500 years ago, and range all the way from that of taking a cheerful attitude to existence in general, to an attempt at a scientific physical treatment of a particular ailment

Mardukapaliddin who lived during the reign of Sargon II, was a logical ancestor of M Coué, as can be seen from one of his letters to the king [15] "Regarding that which the king my lord has spoken, saying 'My side and my feet I cannot move and my eyes I cannot open I am bald and worn out because of the fever It consumes within the bones,' thus it is there is no sin Ashur, Bel and Nabu will establish health" The context is broken for three lines, but from what follows one is tempted to supply a well known modern formula At any rate he goes on "The disease of the skin will go away It is favorable exceedingly (i e, in every way) Let them proclaim the truth According as it is good, let them feed him"

Mental healing, complete rest and sanatorium practice were not beyond the ken of the Assyrians in principle, as the following excerpt from a report [16] from the physician Arad-Nana to Esarhaddon will show "It is exceedingly well with the crown prince The ritual which we performed for restoring him, we gave for five-sixths of a double hour The day he came, he tarried He gained strength He remained until he had completed a month (?)"

Another case reported in the same letter shows a sense of

[14] No. 5 [15] No. 348. [16] No 108.

real scientific skill in the treatment of hemorrhage, that must have extended much farther The passage runs thus "In regard to the patient who has a hemorrhage of the nose, the Rab Mugi reports 'Yesterday toward evening there was a severe hemorrhage' Those dressings were not properly applied They are placed over the nostrils They obstruct the breathing and come off when there is hemorrhage They should be placed within the nostril and then the air would be kept away and the hemorrhage restrained If it is agreeable to the king, I shall go tomorrow and give instructions Now meantime let me hear of his condition"

The following prescription [17] for the exorcism of evil spirits taken from a letter of Mardukshakinshum to the king will show that the principle of homeopathy, if not quite in our acceptation, is no new invention of our day "In regard to the incantation ceremonies beginning 'Art thou the evil (spirit)?' about which the king my lord has written, in order to drive out the evil spirit and 'the one that falls from heaven,' they perform rites according to whatever has attacked him The conjurer shall approach, a wild swine, a kaku bird and a thorn bush on the doorposts he shall hang up The conjurer shall put on a red garment, a red bird shall be placed, a raven on his right, a falcon on his left he shall smite with a lash The incantation 'Art thou the evil spirit?' they shall recite He shall complete it Together with a second conjurer having a censer and a torch at their sides he shall march around the bed of the patient The incantation 'Go forth,' as far as the gate they shall recite The gate they shall conjure Morning and evening he shall perform the rites until the demons have been driven out" Of course in true professional style nothing is said too definitely about the recovery of the patient

Among remedies may be mentioned oil of a poisonous plant and oil of ironwood (?),[18] a concoction made by boiling a purallu stone with the sihhi plant,[19] anointing the body against the action of the wind,[20] bathing the hands and feet with the

[17] No 24

[18] No 570

[19] No 570

[20] No 110

distillation of the Lid-Ru-Sha plant and kulkulanu herbs,[21] the prescribed drinking of blood,[22] ointment for application to the affected parts of the body, lotions of oils[23] and the poultice of licorice

As a last item may be mentioned the attention given to the teeth and the estimate held of the effect of the state of the teeth on the general health of the individual

The first instance[24] deals with a tooth of one of the sons of Esarhaddon, probably Ashurmukinpalua, and is reported by Arad-Nana as follows "Concerning the recovery of the tooth of which the king my lord has inquired, I am improving very much the condition of the tooth"

My last citation is from a letter,[25] from which the writer's name has been broken away, but it is quite probably Adadshumusur, and if so it is addressed either to Esarhaddon or Ashurbanipal It contains the following of interest in this connection "Regarding that which the king my lord has written saying 'According to thy usual integrity send,' I have spoken the truth with the king my lord The burning of his head, his hands and his feet wherewith he burns is because of his teeth His teeth should be drawn His residence should be sprinkled He has been brought low Now he will be well exceedingly " We can well understand why the king wished to make sure of the diagnosis The Assyrians never even advertized painless dentistry, they had a brutal way of gaining their objectives regardless of human feelings

The foregoing citations by no means cover all references to medicinal practice in the royal Assyrian letters I have endeavored, however, to bring together in this manner such references as would show rather the range of usage and the outstanding and characteristic aspects of medicine as understood in the Assyrian Empire of that day

[21] No 450
[22] No 740
[23] No 391
[24] No 109.
[25] No 586.

University of Michigan

METEOROLOGICAL DATA, DOUGLAS LAKE, MICHIGAN *

FRANK C GATES

In response to repeated requests to make available the meteorological data obtained at the Biological Station of the University of Michigan at Douglas Lake, Cheboygan County, Michigan, since 1918, the following paper is written, bringing the records to date The data from 1912 to 1918 were printed in the *21st Report of the Michigan Academy of Science*, pages 373 to 378 Yearly summaries have been published for the following years in the *Reports* and *Papers* of the Michigan Academy of Science 1919, in the *22d Report*, page 213, 1920 and 1921, in *Papers*, II 162–163, and the 1922 summary in *Papers*, III 301–302

Throughout this article, temperature is expressed in degrees Fahrenheit, precipitation in inches and evaporation and solar intensity in c c per day All averages are calculated from the grand totals Averages for temperature and precipitation are based on four to eight years of record in June, twelve years in July and most of August For evaporation during July and the first three-fifths of August, the records are based on eight years, while those for solar intensity are based on four years' records for the same period

METEOROLOGICAL SUMMARY FOR 1923 (Table No I)

June, 1923 — After the heavy snows of the winter, the lake was unusually high and somewhat colder than average through June The month, however, was very pleasant, with about the

* Contribution No 209 from the Botanical Laboratory of the Kansas State Agricultural College, Manhattan, Kansas, and a contribution from the Biological Station of the University of Michigan.

normal temperature and precipitation, although virtually all of the latter occurred in the early part of the month

July, 1923 — In the July following, while the average maxima were a little above average, the minima were distinctly below This made the month a little below average The precipitation consisted of very light showers The vegetation was seriously affected by the dry weather — still fires were not frequent

August, 1923 — The month of August was very pleasant, being both cool and dry There was no really very warm weather Precipitation consisted of showers of rather small amount until the heavy rain of the 27th–28th This rain affectively broke the drought which had lasted with scarcely a break from the seventh of June The month was noteworthy for twice breaking the lowest minimum experienced at the Biological Station during the month First, a new record of 39° was established on August 23 and three days later on August 26 this was pushed down to 37°

Metforological Summaries, 1912–1923 (Table No II)

This table includes Table No 3, previously published, but brings it through 1923 The summaries of evaporation from standard Livingston atmometers and of solar intensity are also included Solar intensity is expressed as the cubic centimeters of water evaporated from a black spherical atmometer in excess of that evaporated from the white bulb

Meteorological Averages (Table No III)

In this table various meteorological features are shown for each fifth of a month In June, the temperature and precipitation figures are for from four to eight years of record, as shown in the table, those for July and August, except the last period, for twelve years The averages for evaporation are based on eight years of record, while those of solar intensity are based on four years of record In each case the number of days missing from the period as just defined is given by an exponential figure

METEOROLOGICAL DATA, 1919-1923 (Tables No IV and V)

The daily maximum and minimum temperatures and precipitation for the days indicated bring the printed record to date All of these records have been made with standard weather bureau instruments As previously stated in the *21st Report of the Michigan Academy*, the records from 1912 through 1918 were taken from a Sixe thermometer and funnel rain-gauge

EVAPORATION AND SOLAR INTENSITY (Tables No VI and VII)

Studies in evaporation from different plant habitats have been made since 1915 During the early studies an atmometer was maintained on the Station grounds and read at the same time that those in the field were read During these studies cylindrical non-rain-correcting Livingston atmometers were used Spherical types were introduced in 1917 Blackened cups were also introduced in the same year With these early records consideration must necessarily have to be taken of the fact that varying amounts of rain and dew entered the instruments and records from an atmometer as a standard are therefore too low This is especially so of 1915 in which there were a large number of rainy days during the summer While this would not necessarily interfere with the comparing of records from different localities, it would be inimical to a satisfactory understanding of the absolute value of the evaporating powers of the air of a region With the development of a rain-correcting device, the Livingston-Shive rain-correcting atmometer was set up in 1919 and daily records maintained through the summers thereafter While the readings were made two or three times daily, the results in the table following are for the 24 hours ending at 7 P M of the dates given A comparison of the rain-correcting and ordinary mounting showed that it was no uncommon occurrence for some two to four c c to be taken in by the non-rain-correcting atmometer in an ordinary rain and even up to 12 c c in a severe driving rain With the development of Musch valves the Gates modification of which was employed in 1922, it was found that although the Musch valve mitigated very decidedly

the amount of water entering in rain, it did not eliminate it Approximately half a cubic centimeter went in the instrument before the valve began to operate However, although this valve is quite efficient against rain, it is very much less so against dews Extreme cases noted were the addition of as much as 7 c c in a night under the most favorable conditions This would seem to indicate that even the Musch valve is not sufficiently accurate for use as a standard for evaporating power of the air, although of course it may be satisfactory for general comparative results

Table No 6 shows the evaporation for the periods given between 1915 and 1922 During the first three of those years, the periods are of varying lengths as shown by the brackets in each case The first figure in each case is the average evaporation per day during the period The second, in parentheses, is the total evaporation during the period During the remaining years the daily evaporation from a standard atmometer is shown and in most cases also the evaporation from a black atmometer during the same period The excess of evaporation from the black bulb over that from the white one gives a measure of the solar intensity This is shown in Table No 7 It has amounted to as much as 30 6 c c in a day The period covered by these records includes that of greatest intensity during the year

Kansas State Agricultural College
Manhattan, Kansas

TABLE I

Meteorological Summary for Summer of 1923

Month	June	Departure	July	Departure	Aug	Departure
Days of record	24		31		31	
Absolute Maximum	95	−1	94	−10	89	−10
Average Maximum	79 2	+1 9	81 6	+1 4	74 7	−1 8
Absolute Minimum	37	+9	45	+6 5	37 *	0
Average Minimum.	52 5	−0 9	53 0	−3 8	49 4	−6 0
Mean Temperature	65 9	+0 5	67 3	−1 2	61 6	−4 4
Precipitation	1 85	−0 17	1 62	−0 51	3 21	+0 16
Days of Precipitation	5	−1 2	10	+0 9	8	−0 4

* New record

TABLE II

WEATHER SUMMARIES, DOUGLAS LAKE, MICHIGAN

	Temperature					Precipitation		Evaporation	Solar Intensity
	Abs Max	Aver Max	Abs Min	Aver Min	Mean	Ppt	Days Ppt		
July, 1912	95	77 6	45	57 5	67 7	1 06	9		
Aug 1912	84	68 7	41	53 8	61 2	6 79	11		
July, 1913	93	78 5	42	56 7	67 8	3 07	10		
Aug, 1913	97	82 0	46	60 1	71 0	0 51	3		
July, 1914	94	81 8	46	58 2	70 0	1 84	7		
Aug, 1914	98	80 0	46	56 5	68 0	1 71	8		
July 1915	92	77 6	44	54 6	66 1	1 69	13	14 2	
Aug 1915	84	73 1	48	55 6	64 1	3 76	7	11 4	
July, 1916	102	87 3	44	61 2	74 2	1 07	5	45 0	
Aug, 1916	99	82 3	42	59 4	70 7	1 66	7	27 0	
July, 1917	104	81 3	50	60 3	70 9	1 33	10	36 3	11 0
Aug, 1917	86	76 2	43	56 6	66 2	2 14	9	24 3	6 1
July, 1918	98	79 2	39	55 2	67 2	1 39	7	29 9	
Aug, 1918	90	79 9	42	55 9	67 6	2 52	8	25 4	
July, 1919	96	81 8	38 5	55 2	66 9	1 23	6	31 1	16 1
Aug 1919	90	76 4	46	56 3	66 4	2 03	5	22 5	11 9
June, 1920	96	78 3	43	56 2	67 3	2 34	10		
July, 1920	87	73 1	39 5	52 4	62 7	2 77	11	32 6	8 6
Aug, 1920	88	76 4	40	53 0	64 7	3 54	6	28 8	6 2
June, 1921	91	82 6	28	54 6	68 6	1 11	5		
July, 1921	100	87 6	52	62 8	75 2	2 41	9	34 1	17 9
Aug, 1921	87	72 4	43	54 2	63 3	4 13	11	23 4	11 7
June, 1922	87	71 8	30	50 5	60 9	2 92+	6		
July, 1922	87	74 4	42	54 1	64 3	6 05	12	21 9	9 3
Aug, 1922	91	76 6	45	55 9	66 1	2 27+	4	19 0	12 4
June, 1923	95	79 2	37	52 5	65 9	1 85	5		
July, 1923	94	81 6	45	53 0	67 3	1 62	10		
Aug, 1923	89	74 7	37	49 4	61 6	3 21	8		

TABLE III

METEOROLOGICAL AVERAGES 1912–1923, DOUGLAS LAKE, MICHIGAN

	Yrs of Record	Absolute Maximum	Absolute Minimum	Average Maximum	Average Minimum	Mean	Precipitation	Days Precipitation	Maximum Precipitation in one day	Evaporation	Solar Intensity
June 1–6		84	28								
7–12	4	96	38	77 6[2]	64 1[3]	65 9	0 58	2 5	1 20*		
13–18	4	92	34	76 3	51 2	63 7	1 00	2 3	2 24		
19–24	7	95	43	78 3[3]	54 6[4]	66 5	0 15[12]	0 6	0 54		
25–30	8	92	30	77 0[3]	53 2[4]	6› 1	0 29[4]	0 9	1 10		
Average or extremes		96	28	77 3	53 4	65 4	2 02	8 2	2 24		
July 1–6	11	100	39	79 6[3]	54 8[3]	67 2	0 44[3]	1 6	1 00	31 1[16]	12 9[3]
7–12	11	99	38 5	78 8	55 3	67 1	0 56	2 0	1 73	29 3[15]	12 5
13–18	12	98	44	79 7	57 0	68 3	0 32	2 1	1 27	30 1[5]	13 7
19–24	12	100	46	81 2	57 5	69 3	0 36	1 3	0 82	33 0[8]	14 9
25–31	11	104	41	81 3	58 8	70 1	0 45	2 1	0 85	26 8	11 6
Average or extremes		104	38 5	80 2	56 8	68 5	2 13	9 1	1 73	29 9	13 1
Aug 1–6	11	99	42	77 1	55 5	66 3	0 47	1 7	1 97	27 3	11 9
7–12	12	98	42	77 1	56 2	66 6	1 11	2 5	2 20	21 5	11 1
13–18	12	97	40	77 3	55 7	66 5	0 57	1 6	1 28	24 7[5]	8 3[6]
19–24	12	97	30	75 1[15]	55 0[12]	65 0	0 49[10]	1 3	0 98		
25–31	7	88	37	73 1[18]	52 9[16]	63 0	0 42[13]	1 3	1 92*		
Average or extremes		99	37	76 5	55 4	66 0	3 05	8 4	2 20	24 5	10 7

* 2 days

TABLE IV

MAXIMUM AND MINIMUM TEMPERATURES, DOUGLAS LAKE, MICHIGAN
(DEGREES FAHRENHEIT)

	1919		1920		1921		1922		1923	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
JUNE 4						28				
5						30				
6							81			
7					70	38	87	62		
8					79	42	76	65	75	54
9			90	69	83	57	75	57	70	38
10			96	56	80	59	64	55	79	44
11			78	64	78	56	64	59	79	49
12			88	64	85	48	58	50	70	50
13			85	60	71	60	65	34	73	41
14			92	60	79	46	76	54	57	47
15			76	66	85	46	72	46	72	37
16			66	56	87	56	68	51	79	41
17			67	52	91	60	63	52	90	45
18			73	54	72	60	80	49	91	56
19	92		76	50	84	50	75	57	87	71
20	85	67	78	46	85	46	69	51	87	64
21	85	63	63	53	90	53	69	54	90	63
22	91	55	66	52	86	63	73	45	95	63
23	94	59	73	50	77	59	87	49	95	63
24	90	62	74	44	73	55	77	50	92	65
25	82	68	81	43	81	52	62	42	84	64
26	80	63	87	52	91	57	71	30	70	60
27	69	54	84	60	85	64	68	45	70	53
28	67	41	83	68	85	63	68	52	65	48
29	82	35	73	65	90	61	67	49	72	47
30	86	50	73	53	89	59	78	54	80	45
JULY 1	92	49	66	53	92	58	74	58	82	48
2	96	57	76	55	96	62	72	53	82	51
3	92	60	70	58	100	65	60	53	79	48
4	87	66	67	50	99	67	72	49	84	45
5	75.5	61	77	39.5	99	65	82	42	74	48
6	79	56	63	53	99	69	77	60	80	54

TABLE IV — *Continued*

	1919		1920		1921		1922		1923	
	Max.	Min	Max	Min	Max	Min	Max	Min	Max	Min
July 7	73 5	49	66	53	99	66	65	52	83	59
8	78	38 5	72	47	80	67	68	47	85	49
9	90	54	76	52	88	66	73	51	85	54
10	67	54	81	48	89	61	73	60	73	63
11	74	38 5	86	49	95	61	72	58	82	49
12	77	54	83	53	95	67	64	52	85	50
13	83	45	87	60	95	67	78	49	85	45
14	84	54	70	54	79	69	81	50	74	52
15	72	56	62	54	82	65	83	54	78	57
16	80 5	45	66	49	83	54	87	60	84	58
17	89	58	76	47	90	55	72	62	89	58
18	90	58	65	55	81	67	70	55	89	48
19	89	58	72	53	76	66	73	55	91	54
20	92	57	81	46	77	61	78	48	94	65
21	81	60	76	56	86	58	82	52	85	54
22	77	56	81	47	87	52	72	60	83	51
23	90	51	72	53	90	61	69	59	66	50
24	75	56	64	58	90	63	75	50	74	56
25	80	50	64	58	85	68	78	49	76	56
26	91 5	64	70	44	89	57	81	52	82	49
27	85	67	81	43	85	69	75	58	76	59
28	73 5	63	78	59	75	64	74	60	65	54
29	75	60	79	66	82	63	78	45	84	45
30	73	54 5	73	57	88	58	75	55	88	59
31	74	61	65	56	66	55	74	60	92	55
Aug 1	70	55	63	49	68	52	77	60	81	63
2	74	57	70	50	72	45	78	58	81	61
3	75	55	77	44	74	51	77	58	87	49
4	84	62	83	46	85	53	75	59	71	58
5	77	62	78	57	87	60	69	57	80	54
6	90	56 5	81	53	78	64	66	50	78	45
7	71	57	85	57	68	54	69	61	72	52
8	65 5	47	84	61	66	55	76	49	75	48
9	69	46	76	64	84	47	72	46	85	42
10	78	47	82	57	78	64	73	52	83	50
11	83	48 5	82	62	68	59	79	48	89	48
12	82	55	73	62	74	55	83	55	79	62
13	82	52	64	60	68	54	85	57	78	54

TABLE IV — *Concluded*

	1919		1920		1921		1922		1923	
	Max	Min	Max.	Min	Max	Min	Max	Min	Max	Min
Aug 14	74	52	70	59	67	54	91	59	81	56
15	83	55	81	55	73	49	89	63	70	40
16	79	60	80	54	76	52	88	64	78	41
17	72	61	80	52	64	56	86	65	70	40
18	67	59	81	48	67	57	70	60	73	46
19	75	61	84	48	71	46	67	54	71	54
20	86	58	88	54	65	55	71	47	76	47
21	73	62	62	58	67	43	67	45	60	53
22	78	62	66	44	72	43		63	59	46
23	86	61	70	40	78	53			70	39
24	71	62	72	42	66	54			58	46
25	64	56	78	48	75	55			65	45
26					74	53				37
27					72	65				46
28					71	63			61	55
29						60			74	52
30									80	47
31									82	55

TABLE

Precipitation in Inches, Douglas Lake, Michigan

	1919	1920	1921	1922	1923
June 4					
5					
6					
7					1 20
8					
9		Tr		0 50	
10		0 29	0 01	0 01	
11		0 14		0 06	
12		0 09	0 02		
13		0 03			
14				0 05	0 63
15		0 29			0 01
16			0 03	2 24	
17		0 20			
18			0 51		
19					
20					Tr
21		0 21			
22					
23			Tr		
24	0 02	Tr	0 54		
25	Tr				0 01
26					
27		0 09		0 06	
28		0 67		Tr	
29		0 33			
30				Tr	Tr

TABLE V — *Continued*

	1919	1920	1921	1922	1923
JULY 1		0 06		Tr	Tr
2		0 31			
3					Tr
4	0 11				
5				Tr	0 41
6		1 00		0 85	
7		0 17	0 95	0 87	0 01
8			0 07	Tr	
9	Tr			0 37	0 03
10				0 05	0 15
11				0 03	
12	0 02			1 73	
13		0 25	Tr	0 01	
14	0 01		0 21		0 03
15					0 35
16					
17		0 18	0 01	1 27	
18		0 28	0 44		
19					
20					Tr
21	0 12				
22				0 68	
23		0 37	0 01	0 03	0 55
24		0 01			
25					
26	0 25		0 07		
27	0 72		0 61	0 06	0 02
28		0 13			0 04
29		0 01			
30	Tr		Tr	0 10	0 03
31			0 04		

TABLE V — *Concluded*

	1919	1920	1921	1922	1923
Aug 1					
2					0 04
3			Tr		Tr
4			Tr		
5		Tr		Tr	
6		Tr	0 01	1 13	Tr
7	Tr	0 11	0 30	0 71	Tr
8		1 61	0 01		
9		0 20		Tr	
10			0 05		
11			0 40		
12		0 39			Tr
13	0 49	Tr	1 14		
14					0 06
15	Tr				
16	0 12				
17	0 32		1 28	0 42	Tr
18	0 63				0 18
19			0 58		
20		0 25	0 11		
21	0 47	0 98		0 01	0 55
22					
23					Tr
24					0 38
25					
26			0 18		
27			0 07		1 92
28			Tr		
29					0 08
30					
31					

TABLE VI

Evaporation, Douglas Lake, Michigan
(c. c. per day, ending 7 P.M.)

	1915	1916	1917		1918	1919		1920		1921		1922	
	White	White	White	Black	White	White	Black	White	Black	White	Black	White	Black
June													
18												23.5	43.2
19												27.3	46.9
20												20.2	32.7
21												30.3	43.9
22												30.9	44.8
23												46.0	53.5
24												50.6	66.1
25												24.8	35.4
26								40.0	[illegible]9.5			32.9	39.0
27								40.2	44.[illegible]			16.1	19.1
28								34.7	40.1			13.9	21.6
29								14.2	19.2			25.0	34.2
30								31.4	41.8			22.0	33.1
July													
1						25.5	38.2	16.9	16.9			17.1	22.7
2						43.1	63.7	22.0	44.1	37.4		22.2	29.6
3						50.2	69.2	27.4	31.4	41.1	69.2	21.0	27.0
4						31.7	48.2	36.1	45.3	41.8	62.5	28.0	33.0
5						31.7	48.2	33.0	41.5	40.9	65.3	40.1	
6						30.8	61.4	6.0	6.0	37.7	50.7	34.2	35.9
7					39.1	35.2	59.2	13.0	17.9	38.1	52.7	6.8	9.8
8					41.9	37.0	49.6	22.8	29.5	10.7	22.5	16.7	24.1
9					35.0	49.3	67.8	35.6	41.5	41.1	61.7	13.1	17.6
10					44.2	22.4	26.4	33.9	45.1	32.7	51.9	11.0	14.6
11					9.2	30.1	50.1	45.2	60.4	47.0	68.9	8.7	18.0
12					35.9	29.9	46.0	51.2	77.6	30.9	55.6	5.2	5.2
13	14.8 (74)				34.0	35.6	49.5	53.4	60.0	45.8	67.6	17.0	36.5
14					31.3	22.0	30.5	33.9	46.1	20.9	37.1	36.3	53.7
15					18.9	14.1	26.4	46.5	54.4	46.8	65.3	27.1	40.7
16					10.6	37.4	56.9	24.5	33.2	35.6	56.0	31.7	43.9
17					9.7	44.9	65.5	43.0	50.3	47.5	73.0	19.5	28.4
18		50.2 (300)			20.4	40.0	60.5	13.8	14.1	11.3	14.7	20.7	34.0
19	14.0 (98)				40.5	28.2	54.6	30.3	42.2	23.3	36.6	24.1	42.3
20					38.6	27.7	47.3	40.7	50.6	42.0	59.9	26.3	44.3
21					63.9	10.6	19.1	32.8	41.6	37.6	58.7	37.8	51.7
22					57.5	25.5	50.1	34.6	49.2	39.7	57.4	5.6	5.6
23		42.7 (194)	20.4 (61)	28.8 (86)	25.8	59.0	76.4	19.0	26.0	46.7	67.5	3.3	4.6
24					24.4	29.0	51.4	33.6	41.3	51.5	73.0	30.8	46.6
25	16.0 (112)				3.2	25.7	37.3	35.2	43.8	30.0	45.3	30.4	45.0
26		15.6 (44)	28.4 (97)	37.5 (128)	17.9	26.4	34.6	33.3	44.3	27.8	41.5	28.1	43.7
27					27.6	31.4	31.4	35.0	43.6	25.6	30.1	21.3	37.5
28					29.4	25.1	45.5	33.8	39.5	13.9	25.5	35.1	50.1
29		43.0 (137)	56.4 (205)	71.3 (259)	17.9	25.5	45.5	50.1	59.1	19.8	32.7	31.5	43.3
30					32.2	12.3	19.6	33.8	41.8	22.6	47.9	14.4	23.7
31					29.0	20.7	33.7	40.9	49.2	35.9	48.9	14.4	22.0

TABLE VI — *Concluded*

Aug	1915	1916	1917		1918	1919		1920		1921		1922	
	White	White	White	Black	White	White	Black	White	Black	White	Black	White	Black
1	9 3 (65)				44 2	33 4	48 2	35 8	43 1	19 7	36 9	14 8	29 2
2		26 8 (97)	40 1 (128)	48 0 (156)	34 0	31 7	47 3	37 1	46 6	26 5	43 8	26 8	42 9
3					15 6	22 9	35 5	39 2	49 3	28 8	42 6	21 7	35 9
4					31 3	26 4	35 5	47 4	61 6	28 8	45 6	22 6	34 3
5					18 4	12 3	22 3	25 6	30 1	39 0	52 3	17 7	24 7
6		27 5 (146)	24 6 (99)	32 5 (131)	28 1	25 5	39 1	26 2	38 4	35 4	45 8	2 3	2 3
7					17 9	15 8	29 1	32 4	54 3	19 1	19 7	8 6	16 2
8	10 4 (73)				0	25 [illegible]	41 9	19 1	19 1	20 9	34 4	26 7	39 6
9			18 0 (50)	21 6 (60)	0	26 4	42 8	11 8	16 6	35 2	52 4	22 7	34 4
10		16 0 (30)			30 8	25 [illegible]	41 0	21 3	30 9	30 9	43 4	18 1	33 1
11					30 8	28 2	41 9	26 9	34 9	7 6	7 6	27 0	39 5
12			12 8 (51)	18 4 (73)	23 0	20 9	42 8	15 0	18 5	14 3	28 5	32 6	45 1
13		40 0 (164)			34 5	24 6	28 2	6 5	9 7	6 4	7 6	23 8	
14					33 6	10 6	21 8	14 4	19 3	29 2	44 3		
15	14 6 (102)				37 7	17 6	28 2	29 4	39 9	37 6	52 5		
16			28 3 (85)	32 3 (97)	29 0	31 7	41 0	39 0	48 3	30 9	44 1		
17		23 9 (139)			28 [illegible]	11 4	14 6	33 6		9 2	9 2		
18					35 4	4 4	11 8	39 0		18 8	33 5		
19					38 6	22 9	40 0	45 7		5 0	5 0		
20					0					19 3	32 7		
21					21 7					21 4	36 6		
22		26 5 (71)								23 0	36 3		
23										25 4	41 9		
24										26 0	37 3		
25										24 2	39 4		
26										26 4	38 3		
Season total	524	1322	766	990	1280 2	1390 7	2117 7	1727 1	2042 9	1793 6	2420 4	1818 0	1825 8
Total days	40	40	27	27	46	50	50	55	52	56	55	57	55
Rate per day	13 1	33 1	28 4	36 7	27 8	27 8	42 4	31 4	39 3	32 0	44 0	23 1	33 2

TABLE VII

EFFECT OF SOLAR INTENSITY ON EVAPORATION, DOUGLAS LAKE, MICHIGAN

(c c per day)

	1919	1920	1921	1922		1919	1920	1921	1922
June 18				19 7	July 23	17 4	7 0	20 8	1 3
19				19 6	24	22 4	7 7	21 5	15 8
20				12 5	25	11 6	8 6	15 3	14 6
21				13 6	26	8 2	11 0	13 7	15 6
22				13 9	27	0	8 6	4 5	16 2
23				7 5	28	20 4	5 7	11 6	15 0
24				6 5	29	20 0	9 0	12 9	11 8
25				10 6	30	7 3	8 0	25 3	9 3
26		10 5		6 1	31	13 0	8 3	13 0	7 6
27		4 3		3 0	Aug 1	14 8	7 3	17 2	14 4
28		5 4		7 7	2	15 6	9 5	17 3	16 1
29		5 0		9 2	3	12 6	10 1	13 8	14 2
30		10 4		10 5	4	9 1	14 2	16 8	11 7
July 1	12 7	0		5 6	5	10 0	4 5	13 3	7 0
2	20 6	12 1		7 4	6	13 6	12 2	10 4	0
3	19 0	4 0	28 1	6 0	7	13 3	21 9	0 6	7 6
4	16 5	9 2	20 7	5 0	8	16 4	0	13 5	12 9
5	16 5	8 5	24 4		9	16 4	4 8	17 2	11 7
6	30 6	0	22 0	1 7	10	15 5	9 6	12 5	15 0
7	24 0	4 9	14 6	3 0	11	13 7	8 0	0	12 5
8	12 6	6 7	11 8	7 4	12	12 9	2 6	14 2	12 5
9	18 5	5 9	20 6	4 5	13	3 6	3 2	1 2	
10	4 0	11 2	19 2	3 6	14	11 2	4 9	15 1	
11	14 0	15 2	21 9	9 3	15	10 6	10 5	14 9	
12	16 1	26 4	24 7	0	16	10 2	9 3	13 2	
13	13 9	6 6	21 8	19 5	17	3 2		0	
14	8 5	12 2	16 2	17 4	18	7 4		14 7	
15	12 3	7 9	18 5	13 6	19	17 1		0	
16	19 5	8 7	20 4	12 2	20			13 4	
17	20 6	7 3	25 5	8 9	21			15 2	
18	20 5	0 3	3 4	13 3	22			13 3	
19	26 4	11 9	13 3	18 2	23			16 5	
20	19 6	9 9	17 9	18 0	24			11 3	
21	8 5	8 8	21 1	13 9	25			15 2	
22	24 6	14 6	17 7	0	26			11 9	

THE HISTORICAL BACKGROUND OF EASTERN EUROPE

PRESTON SLOSSON

In passing across Europe from the Rhine to the Volga we take the road to Yesterday. Germany east of the Elbe is markedly less like our own familiar world of industry, prosperity and material comfort than western Germany. The Polish lands are again somewhat less disciplined by factory and school than the Prussian lands. Farm-houses are spaced more widely, roads are muddier, rail-routes are fewer, peasant customs and costumes less affected by the influence of the great cities. But Poland, once more, is "western" in contrast to Russia. With the frontier of Russia ends the Roman Catholic Church, the parliamentary State, the traditional culture of Latin, chivalry, nationalism and territorial aristocracy which bind Poland to central rather than to eastern Europe. In Russia we meet a new level of civilization and in some respects, it must be confessed, a lower one. Below a small Europeanized upper class, now largely dispersed by the whirlwind of revolution, we find a peasant folk, more numerous than all the inhabitants of the United States of America, whose standard of living is rather that of Asia than of Europe.

A majority of them can neither read nor write. Their death rate, apart from either war or revolution, is nearly twice that of the cities of western Europe or America. In famine times they die by millions as men die only in the river valleys of China and of India. The factors which have made history for ourselves the faith of Rome, the feudal system, the Renascence, the Reformation, the enlightenment of the eighteenth century, the liberalism and industrialism of the early nineteenth century have touched them hardly at all. Their trade is agriculture, but they

are equally remote from the thrifty French peasant turning every inch of ground into fruitfulness with his spade culture and the shrewd Yankee farmer with his Ford tractors and keen sense of land values The Russian peasant labors, perhaps, as hard as either of them but his rewards are less He must make his own tools, and he does not know how to make the best ones His methods are those of his ancestors, no one has taught him to seek out improvements Markets are very far away, and means of transportation, always inadequate, have not been bettered by years of confusion and civil war To him the revolution meant almost wholly the chance to increase his little farm or strip of common land and thus obviate the old necessity of eking out his meager living by days of extra labor as a farmhand on a great estate or casual labor in the towns

Political power is not his as yet, nor even political liberty By a strange paradox, Russia, the most purely agricultural of all great nations, is the one in which townsmen most completely dominate the national destinies The Soviet constitution discriminates against the peasant Not only is the proportionate voting power of the town proletariat greater than that of the peasants, but the delegates from the great cities are chosen to the all-Russian Congress of Soviets almost directly, while the vote of the peasant is filtered through a long series of district, county and provincial bodies Any attempt at real insurgence is repressed at once by Bolshevik armies By mere possession of the fields and their crops the peasants have been able to wring some vital concessions from the Government In spite of the law nationalizing all lands, the peasants have in practice been permitted to hold the lands they actually occupy and cultivate as if they were peasant freeholds under a system of private property Even the old village commune which once collectively administered the land is said by Russian observers to be giving way to individual farms Also the peasant has won the right again, at first in despite of law, to sell his goods at market price instead of surrendering his entire surplus to the Government for distribution But in all other things the affairs of Russia at home and abroad are wielded by a bureaucracy es-

sentially as alien to the country-side as the old bureaucracy of the Tsar.

In one respect the Russian peasant is better off than the medieval serf. He can wander, there is a shifting frontier. The endless forests, farmlands and grassy steppes of Russia and Siberia have nothing to hold the native to one spot. If his smoky wooden hut should catch fire — as it is almost sure to do at least once or twice a lifetime — he moves. If the used-up, overhandled land fails to maintain its former yield of crops — he moves, it is cheaper than buying fertilizer and easier than studying the rotation of crops. If oppression from Tsar or Soviet official becomes unendurable — he moves. Different in so much else, the Russian is like the American in this, that he will probably die in another place than that where he was born. "The mountain," it is said, "holds its own and beckons its wanderers to return. The plain bids you ride at a venture and go where your eyes glance." In this way half Europe and half Asia have been penetrated by the Russian frontiersman, tough, stolid and cheerful, ax over his shoulder, fraternizing readily with the natives among whom his lot is cast — an ideal pioneer. Hardships mean little to a man who may better his lot in a new place and can hardly make it worse. Thus to balance our old frontier, the "Wild West," Europe has created a "Wild East," that shifting borderland of the Caspian and the Urals where the last reaches of European civilization merge into the utter barbarism of Central Asia.

Southeastern Europe in many ways shares the backwardness of Russia. Here in the Balkans also we find illiteracy, poverty, primitive methods of industry and agriculture, the ideas and ideals of dead centuries. But we find also a fighting nationalism, a local territorial tradition, and a participation of the peasantry in the game of politics, which distinguish Bulgaria and Serbia, for example, from the Russian scene. Class antagonisms are perhaps less marked than in Russia, for the retreat of the Turk, like the retreat of some great glacier, left society ground down to a fairly uniform level. But national hatreds and feuds make every frontier an entrenchment and degrade diplo-

macy to the level of conspiracy And now the succession states of what was once the Austro-Hungarian Empire form a new Balkans, better educated and more industrialized indeed but equally the victim of military and political rivalry

From Poland, Russia, the Danube lands and the Balkan highland come many of our latest recruits to American citizenship They all desire to become good American citizens, but inevitably they bring with them the handicap of their old environment Because of this, there is great danger that Americans of west European ancestry misunderstand their new compatriots Misunderstanding usually takes the form of underestimation We do not extend to the rivalry of Serb and Bulgar or Pole and Lithuanian the same tolerance which we have learned to grant to the rivalry of Irishman and Englishman We call a people stupid because they are illiterate, although this fact may prove nothing but the stupidity of their former rulers who failed to supply the needed schools We call a people naturally warlike and troublesome although they may be peace-loving farmers whose little states were pushed about like pawns upon the diplomatic chessboard to suit the plans of the Great Powers In every Russian we suspect a Bolshevik although the majority of Russians have but endured Bolshevism as Belgium endured a German army of occupation during the war That eastern Europe is backward cannot be denied by the currently accepted standards of our civilization such as the standard of living, education, industrial productivity, good government and public health Are the causes of this backwardness inherent or do they lie in certain traceable historical events which we must study in order to understand the people whom they have affected?

Much is said today about the all-determining factors of race or climate, but we cannot find in them the key to the unfortunate condition of eastern Europe Dillon traces the misfortunes of Russia to the native weakness of the Russian character, an anarchic inability for organized coöperation, he calls the Russian the "boneless man of Europe" He explains this character by the intermingling in the Russian of the temperamental Slav with the primitive Finnish tribes of northern Russia But the Slavs

of Bohemia and the Finns of Finland have created republics orderly and progressive, which will bear comparison with the most advanced nations of Europe. Other writers say that the Slavic peoples are mostly of the "Alpine" race, which is alleged to be so inferior to the "great race" of Nordics who have peopled America from northwestern Europe. But if the Poles and Ukrainians are Alpine, so are the Swiss who have established the best governed commonwealth in Europe, the brilliant Italians of the northern provinces and the capable and thrifty peasants of central France. The Russian and Polish literature of the nineteenth century ranks second only to the English and French, and Slavic names are numerous in every branch of art and science. Racial inferiority is evidently not here in case.

Nor can it be contended that the slight climatic difference between the oceanic west of Europe and the continental east is sufficient to account for the difference in culture of the two regions. Much greater differences exist between different parts of our own country without creating any marked effect on American life. The natural resources of eastern Europe are sufficient to maintain the highest civilization. When one considers the high level of prosperity in isolated and arid Australia, perhaps higher than the average even of our own country, one can find no reason in nature's economy for the dire poverty of the rich plains of the Danube and the Dnieper. No doubt the isolation and the cold winters of Russia delayed the coming of civilization to that country, but much greater obstacles have not prevented the development of Canada. Nor can this excuse be offered at all on behalf of the Balkans who shared the civilization of Greece and Rome when our ancestors were still skin-clad savages.

Evidently then we can interpret the troubles of eastern Europe today only by reference to the particular events of their history. And here, I think, we find a more than sufficient explanation for the relative backwardness of this region. In the course of modern history we of western Europe, and particularly the English speaking peoples, have had all the "breaks" with

us, to use a baseball term The greatness of England, for example, is the cumulative result of a vigorous race, a mild but stimulating climate, excellent harbors, extensive deposits of coal and iron, security from invasion by an insular position, and yet close neighborhood to other highly developed nations, the cultural contacts of the Roman faith, the Renascence and the Reformation, an early establishment of national unity under the capable Norman kings, an early emergence from serfdom and feudal tenures, a favorable position for overseas trade and colonial expansion, a successful revolt against royal absolutism at the very time when continental Europe was accepting absolute monarchs, an influx of religious refugees from the continent who were at the same time skilled craftsmen, a liberal tradition in government fostered by the security from foreign invasions and relative freedom from civil wars, a series of political accidents, such as the coming to the throne of a line of German kings who cared little for English politics, which resulted in the establishment of parliamentary government and the cabinet system No wonder that men of English speech believe that progress is the universal law of history!

But how would a Russian look at history? He would see first Greek missionaries bringing religion and civilization to scattered Slavic tribes, but by the same act separating Russia from cultural contact with the Roman Catholic nations of the rest of Europe He would see the vigorous life of the city states of Kiev and Novgorod trampled underfoot by savages from Mongolia and Turkestan Wave after wave of Barbarian nomads sweeping in through the gap between the Urals and the Caspian Huns, Avars, Bulgars, Magyars, Khazars, Patzinaks, Kumans and Tatars, each destroying not only the culture of the Slav but the beginnings of civilization created by the last invaders He would see ages of subjection to Tatar overlords, unspeakable humiliations and a growing habit of servitude He would see independence established under the despotic princes of Moscow who ruthlessly crushed out every aspiration of civic life He would see the massacres of the old aristocracy by Ivan the Terrible, the devastating civil war of the "troublous times", the estab-

lishment of serfdom at the very time when it was disappearing in the west, the ever widening social gulf between the classes He would see Peter the Great bringing European life to a Russia which had become an Asia-in-Europe, but at the same time stiffening militarism and bureaucracy and leading his country into bloody foreign wars He would see Peter's incompetent successors playing his game of repression at home and adventure abroad without his genius for reform and victory He would see the liberal movement bringing to Russia only revolution, and modern industrial invention bringing only factory slavery and the doctrines of socialism The costly blunders of the Crimean and Manchurian wars were followed by the disastrous losses of the Great War, the fall of Tsardom, the civil war which wrecked the republic and the establishment of a class dictatorship on its ruins Had almost any factor in Russian history been different the result would have been better had Christianity come from the west instead of the east, had the Tatar invasion turned aside, had certain Muscovite princes or Russian Tsars never lived, had Peter and Catherine brought relief for the peasants as well as culture for the aristocracy, had the emancipation of the serf begun before it was too late to create a contented class of peasant freemen, Russian life today might be on a level with that of France or Germany

The case of Russia is perhaps extreme, but any patriot of a country of eastern Europe must feel the deep note of tragedy in the history of his fatherland Modern Greece looks back to her golden age more than two thousand years ago, but her immediate past is one of slavery to the alien and barbarous Turkish power What would any country of western Europe be like after some four centuries of Turkish rule? The whole Balkan area and for a time even Hungary underwent the same degrading subjection, unlearning all the habits of civil freedom Slavs and Magyars alike must begin anew their national life from that point in the middle ages where progress was halted by foreign invasion and conquest Poland, Czechoslovakia, the Baltic republics of Lithuania, Latvia, Esthonia and Finland are in somewhat better case, having escaped the decivilizing rule of Turk

and Tatar, but they have been thwarted in their normal national development by the imposition of foreign institutions The mere struggle for national existence exhausted the energies which might have gone into political and economic reform and intellectual achievement The rapid industrial progress of Germany and Italy after their wars of unification as compared with the stagnation which preceded national unity shows how greatly dependent is the progress of a nation on the solution of its main political problem Poland has now the first chance in more than a century, Czechoslovakia in three centuries, of showing what it can do

The effect of foreign rule and conquest on the recently subject nationalities of eastern Europe is evident and familiar Equally important is the fact that serfdom lingered late, as it arrived late, in Poland and Hungary as well as in Russia Even yet a wide social gulf separates the old landholding class from the freedmen who were so recently serfs A disorderly aristocracy, an impoverished peasantry, and a weak and largely alien middle class, such a social structure could not protect the independence of Poland, Hungary and Bohemia from the aggressive energy of the Hapsburg and Hohenzollern despots, and left Russia at the mercy of an unworthy ruling house and a corrupt bureaucracy Deep in the soil of history lie the roots of all that troubles or perplexes us today in eastern Europe and the east European immigrant

UNIVERSITY OF MICHIGAN

EXTRA-CURRICULAR FACTORS AND AFTER-SUCCESS

ADELBERT FORD

WHAT is the relation of a student's life in college to the degree of his success after he graduates? The answer contains, of course, many variables It depends on the nature of the occupation he will follow, it depends on how we measure success It might be interesting to note, however, the extent to which the majority of occupations require certain particular traits

Some time ago Wesleyan University measured success in terms of the ability to get into *Who's Who*,[1] and found that high college grades increased the probability of attaining a place in this collection of famous biographies Dr D E Rice[2] measured success in terms of salary-earning ability, and found that high college grades were correlated with the capacity to earn a good income Pressey and Ralston[3] found that the professional and commercial executives transmitted a superior grade of intelligence to their offspring, indicating that the successful classes, both from the standpoint of money and prestige, were intellectually gifted This latter investigation harmonizes with the conclusions of Terman[4]

In some of the work cited above as many as fifty per cent of the superior students failed to acquire after-success by either the money or the prestige standard as compared with about ninety per cent of the mediocre students who failed to acquire distinction It is the aim of this paper to indicate some reasons why students with superior ability fail after they graduate The suggestion has been made that although high intelligence is

[1] Hollingsworth, H L, *Vocational Psychology*, p 192 ff

[2] *Ibid*, p 195 ff

[3] Pressey, S L, and Ralston, Ruth, *The Relation of the General Intelligence of School Children to the Occupation of the Father*, *Journ. of App Psych*, 3 366 ff

[4] Terman, L M, *The Intelligence of School Children*, p 188 ff

a prime requisite for almost any calling which a graduate pursues, there are many times when peculiar character traits in an individual prevent him from being given a chance to use his intelligence A man with a high intelligence but a disagreeable personality may never get the chance to use his wonderful gift because neither a professional nor a commercial executive wants such a man around Nearly all positions necessitate some degree of social capacity, the quantity depending on the nature of the work and the character of the superior officers

We desired to indicate the relation of the social element to a graduate's success as measured by the money standard The following bit of evidence is admittedly brief and is subject to certain possibilities of error — the questionnaire method always brings in the likelihood of a biased selection in the cases There is the criticism concerning our right to group together a large number of seemingly unrelated occupations and to draw common conclusions We decided to allow membership in campus organizations to constitute a standard for social ability

Questionnaires were sent to two hundred and fifty-eight graduates of 1912 in the College of Literature, Science and the Arts, University of Michigan Ten questionnaires were returned for lack of proper address About forty per cent of the remainder answered, or ninety-eight Fourteen of these were eliminated for insufficient data On these replies were stated the graduate's occupation, salary, and a history of his campus activities while in residence at Michigan

The returned questionnaires were now arranged into two groups, Part I and Part II, strictly at random Part I contained forty cases, Part II, forty-four cases All campus activities of a similar nature were thrown together and an average taken of all the salaries of members in each activity-group 'Non-membership' was considered as a trait, as was 'age' The following table gives a list of the activities derived from Part I with the rank and average salary of members in each group It is perhaps needless to say that the rank of any one factor in the following table may be thoroughly unreliable for lack of cases We have no right, for example, to assume that the

scholastic honorary societies actually belong in Rank 19, we are concerned with campus activities *as a whole, not in particular*

TABLE OF EXTRA-CURRICULAR FACTORS

Rank	Name of Group	Cases	Average Salary
1	Popular honorary	22	$10,649 00
2	Campus committees	11	9,986 00
3	Fraternity presidents	2	9,750 00
4	Michigan Union members	6	8 366 00
5	Debating societies	5	8,350 00
6	Law clubs	6	7,942 00
7	Religious societies	5	7,937 00
8	Michigan Daily staff	7	7 569 00
9	Musical organizations	5	6,680 00
10	Non-membership	6	6,360 00
11	Michigan Union Opera	6	6,316 00
12	Fraternity members	9	6,275 00
13	Lodges	6	6,073 00
14	Major athletics	3	5 866 00
15	Young men	20	5,827 00
16	Old men	20	5,572 00
17	Monthly periodical staff	8	5,493 00
18	Minor clubs	20	5,270 00
19	Scholastic honorary societies	3	3,850 00
20	Language clubs	3	3,233 00

Now there were a great many students who belonged in several activity-groups with widely differing salary-weights We had allowed the average salary drawn by all members in a given activity to stand for the weight of that activity When a student belonged to several activity-groups, the weights for these groups were averaged and allowed to stand for the value of this student's campus activities The following is an example of the method of weighting a single individual's extra-curricular factors Case A belonging in Part I was a member of the following groups

Name of Group	Average Salary
Popular honorary	$10,649
Campus committees	9,986
Michigan Union members	8,366
Young men	5,827
Language clubs	3,233
Average for Case A	$7,610

We thus have $7,610 becoming the "activity weight" for this particular student His salary ten years after graduation was $3,500 His activity weight was therefore above average, while his actual salary was below average It will be seen that a great many cases like this would militate against a high positive coefficient

We now compute the coefficient of correlation for both Part I and Part II by the Pearson formula for the unscattered arrangement of data

$$\Sigma XY$$

$$\Sigma Y$$

The average salary for the cases in Part I was $5,713, the coefficient of correlation for Part I was 62, P E 06565 But it must be remembered that the weights for Part I were so arranged as to secure as high a coefficient as possible, so this correlation figure must be further tested on new and random samples Part II had been reserved for this purpose, having been drawn by lot before any computation was started

The average salary for members in Part II was $4,639 The correlation coefficient was 44, P E 08269, — high enough to be statistically reliable for forty-four cases The weights used for Part II were identical with those used for Part I, so there could be no suspicion of a secondary manipulation of weights producing an exaggerated figure

The significance of the foregoing result does not lead us into assuming that it is more important for a student to be socially minded than intelligent, or that he should spend more time on fraternity activities and dances than on his school work Such a conclusion cannot hold in the face of the evidence we have cited in our introduction Rather we must conclude that intellectual activity is exceedingly necessary on the college campus, that the average post-graduation occupation needs a good scholastic training, but after-success is exceedingly difficult, even for the intellectually gifted, when coupled with an unsocial disposition

University of Michigan

SOME FACTORS GOVERNING THE SEROLOGY OF SYPHILIS BY PRECIPITATION

R L KAHN

STUDIES on the phenomenon of precipitation in syphilis carried out over a period of several years in connection with the development of the author's precipitation test indicate that the following requirements are essential to a practical test concentration, instability of antigen-dilution, correct serum-antigen proportions, uniformity of procedure In the author's test an attempt has been made to meet these requirements

Concentration — The alcoholic extract antigen is prepared with a view to obtaining high concentration Powdered, instead of wet, heart muscle is employed For further dehydration and for removal of fat and non-specific lipoids, the powdered muscle is given preliminary extraction with ether The powder is then extracted with ninety-five per cent alcohol To the alcoholic extract is added a given amount of cholesterin — thereby increasing the lipoid concentration of the antigen In diluting the antigen for use in the tests, a minimum amount of salt solution — determined by titration — is employed When serum is tested with the diluted antigen, it is employed in undiluted form

Instability of Antigen-Dilution — There is a high degree of instability in the antigen-dilution used in the author's test The diluted antigen contains a precipitate which is so unstable as to dissolve readily in serum

Correct Serum-Antigen Proportions — Complete precipitation in serum-antigen mixtures is apparently obtained only when the number of reacting substances in the serum corresponds to the number of reacting substances in the antigen In conformity with this requirement three different serum-antigen proportions are used in the author's test, since serums from different stages of syphilis contain varying numbers of reacting substances

Uniformity of Procedure — The method of antigen preparation has been so standardized as to assure highly constant results in the hands of different workers The various other steps of the procedure have also been sufficiently standardized to reduce the variation in results to a minimum

As a result of the application of these fundamental principles, the author's test possesses the following features (1) The element of incubation is eliminated, precipitates appearing within a few minutes after mixing serum with antigen dilution, (2) The method permits direct quantitative measurement of the serum reacting substances and is especially adapted to serological research, (3) Simplicity of procedure is combined with a high degree of specificity and sensitiveness, as indicated by over 78,000 examinations

BUREAU OF LABORATORIES
MICHIGAN DEPARTMENT OF HEALTH
LANSING, MICHIGAN

VARIATIONS IN THE INTESTINAL FLORA OF RATS

HELEN S MITCHELL

INTESTINAL flora observation on rats is not a new or a unique procedure, for this has been done many times by Rettger and Cheplin and other workers, but there are some rather significant variations with changes in diets which we have noted and which we offer as suggestions for further work rather than as proved facts

Our attention was first called to these variations in making some tests on commercial sugars as to their relative value in changing the intestinal flora The rats for such tests were fed on an almost exclusive meat diet and the proteolytic type of flora thus established would remain consistently such, unless certain forms of carbohydrate or other preparations fed in addition had the power to increase the aciduric type of bacteria By noting the extent of the change and the time necessary for it to take place, consistent results could be obtained in testing the relative value of products in question Our observations in general confirm those previously reported, namely, that the most extensive changes to the aciduric type were obtained with dextrine, lactose, or a combination of the two, and that less marked changes were noted with other carbohydrates such as sucrose, maltose, or corn-starch

Where a *B acidophilus* culture in whey or other medium lacking carbohydrate is fed to "meat" rats, the intestinal flora change is very slight From these experiments we conclude that the presence of a favorable medium for growth is more important than the inoculation with the organism itself

We then became curious regarding the intestinal flora of the rats on our various experimental diets and took a series of pre-

liminary tests At first there appeared to be no correlation between the type of diet and the intestinal flora, except where milk or certain sugars were included in the diet More extensive and careful observation, however, has shown several interesting variations

Observations on a large number of our rats on synthetic paste foods (casein, corn-starch, salt mixture, crisco, and butter fat) showed few acidophilus colonies and a percentage of gram positive organisms ranging from fifteen to sixty per cent The variation was so great that no relationship could be noted except that here, as on the stock diet, the older rats tended to show the greater percentage of proteolytic organisms

The possibility of dietary deficiencies and intestinal flora changes being correlated was then investigated When the diets were deficient in vitamin B, there were almost no acidophilus colonies and the percentage of gram positive organisms was extremely low When yeast or wheat germ was added as a source of vitamin there was improvement, but no significant difference in the source of vitamin used A low calcium diet had no effect upon the intestinal flora

In all cases where casein or egg white furnished the sole source of protein and corn-starch the carbohydrate, there was a small percentage of acidophilus, but where a cereal protein made approximately one-third or more of the protein, there was a definite increase in the number of aciduric organisms varying with the type of cereal In this series of experiments the cereal made sixty-two per cent of the diet and furnished one-third of the protein

	Percentage of acidophilus	Gram pos.	Gram neg.	Coli like
Corn-meal	6	35	65	xx
	10	40	60	x
Oatmeal	20	50	50	x
	25	55	45	x
Whole wheat	15	45	55	x
	17	50	50	x
White flour	5	35	65	xx
	7	40	60	x

One reason for this variation may be in the speed of absorption of the carbohydrate, but I doubt if that could entirely account for the striking differences noted

Another explanation is suggested by the rather surprising results obtained from the feeding of two grams of eighty per cent gluten biscuit to rats on an exclusive meat diet

Rat	Date	Gram		Coli-like	Diet
		pos	neg		50%
No 68	7–20	10	90	xxx	meat
Gluten added	7–20				protein
	7–26	25	75	x	
	7–30	45	55	x	
	8–7	65	35	x	
No 672	9–23	20	80	xxx	100%
Gluten added	9–25				meat
	9–30	35	65	xx	
	10–9	55	45	x	

The change from the typical putrefactive flora to a moderately aciduric type was striking, considering that almost no carbohydrate was included in the diet There would seem to be a definite influence exerted by the type or source of protein Such a result suggests an interesting application in the treatment of intestinal disorders in diabetics where carbohydrates cannot be given for changing the flora

Most of the experiments recorded by other writers and those reported here have been dealing with the possibility of changing the intestinal flora, but few observations have been made concerning the effect that such a change might have on the general condition and growth of the rat Opportunity for such an observation presented itself in connection with a series of experiments conducted with the assistance of Miss E Latimer, where several different sugars as well as starch were used as the sole source of carbohydrate in the diets During the two months' period observed there were marked differences in the growth, general condition and intestinal flora changes

Source of carbohydrate	Gain in weight	Condition	Percentage of acidophilus
Starch	183	good	1 – 10
	217	good	2 – 20
Lactose	149	fair	15 – 97
	158	fair	20 – 93
Maltose	260	excellent	7 – 15
	213	excellent	5 – 10
Dextrine	192	fair	30 – 80
	182	fair	25 – 65
Sucrose	191	good	4 – 17
	199	good	7 – 10

Because of the extreme laxative quality of the lactose, growth was retarded for a period and an astringent had to be administered in order to continue the experiment at all But with all these digressions there was a steady increase in the aciduric type of bacteria in this group Likewise in the dextrine group there was almost complete change to the acidophilus, but in neither of these groups was the condition of the animal as good as on the other diets, especially the maltose

This preliminary experiment would suggest the conclusion that a supposedly beneficial intestinal flora will not alone produce a good condition in a rat, and that where a marked change of flora takes place it indicates a poor utilization of the sugar on the part of the animal itself and consequent retarded growth On the other hand where a carbohydrate is easily utilized by the body, so little of it reaches the colon that the intestinal flora changes are slight When lactose or dextrine are used as only a portion of the carbohydrate, the bacterial change is almost as complete and the untoward effects upon growth and general condition are not observed

Another group of intestinal flora experiments are being conducted in our laboratory under the direction of F T Breidigan in confirmation of the work of Braafladt reported in the *Journal of Infectious Diseases*, November, 1923, to observe the possible influence of kaolin on the intestinal bacteria Rats on an exclusive meat diet with a consequent proteolytic flora were fed one gram of kaolin daily and the result was a definite, although

not complete, change toward the aciduric type The beneficial effect of the kaolin is probably due to adsorption of toxins produced by proteolytic organisms and the consequent establishment of a more favorable environment for the growth of the aciduric types When a new source of kaolin was used for a period, the change was much less pronounced, indicating that various sources of kaolin may have different adsorptive qualities

Histological studies of the tissues of rats showing different types of intestinal flora have shown no consistent abnormalities, the only marked pathological changes being noted in rats on meat diets where a variety of other factors would come into question

It is our conclusion that the chief value of intestinal flora research on rats so far is concerned with the testing of various types of foodstuffs, rather than in attempting to correlate these bacterial changes with the growth and development of the rat, which is susceptible to so many other conditions

In conclusion I wish to thank Dr H Tsuchiya, who made the bacteriological examinations

Helen S Mitchell
Nutrition Research Laboratory
Battle Creek Sanitarium
Battle Creek, Michigan

THE INHIBITION OF THE STOMACH IN NECTURUS

T L PATTERSON

About twenty years ago, Boldyreff (1) working in Pavlov's laboratory discovered that the stomach of the dog when in the empty condition exhibited peristaltic movements These movements contrary to the ordinary gastric peristalsis during digestion were more vigorous and showed a definite periodicity separated by intervening periods of rest This investigator, however, did not connect the gastric contractions with the genesis of the hunger sensation This work was confirmed and extended by Cannon and Washburn (2) in this country and to these authors we owe the actual demonstration of the synchrony of the hunger sensation with the strong contractions of the empty stomach A year later (1912) Carlson (3) and his co-workers demonstrated on man and experimental animals that a certain type of contractions in the empty or nearly empty stomach gave rise to the sensation of hunger by stimulation of the sensory nerves, not in the gastric mucosa, but in the submucosa or muscularis

About eight years ago, after having done considerable work on the movements of the empty stomach of dogs, the author of this paper inaugurated a series of comparative studies on the lower vertebrates with the intention of carrying the investigations to certain of the invertebrate forms At the present time such studies have been made on the frog (4, 5, 6), turtle (4), Necturus (7), and several species of marine mollusks (8) This communication deals with the nervous control of the empty stomach in Necturus

Previous work (7) has indicated that the controlling influence of the vago-sympathetics is largely inhibitory This phenomenon

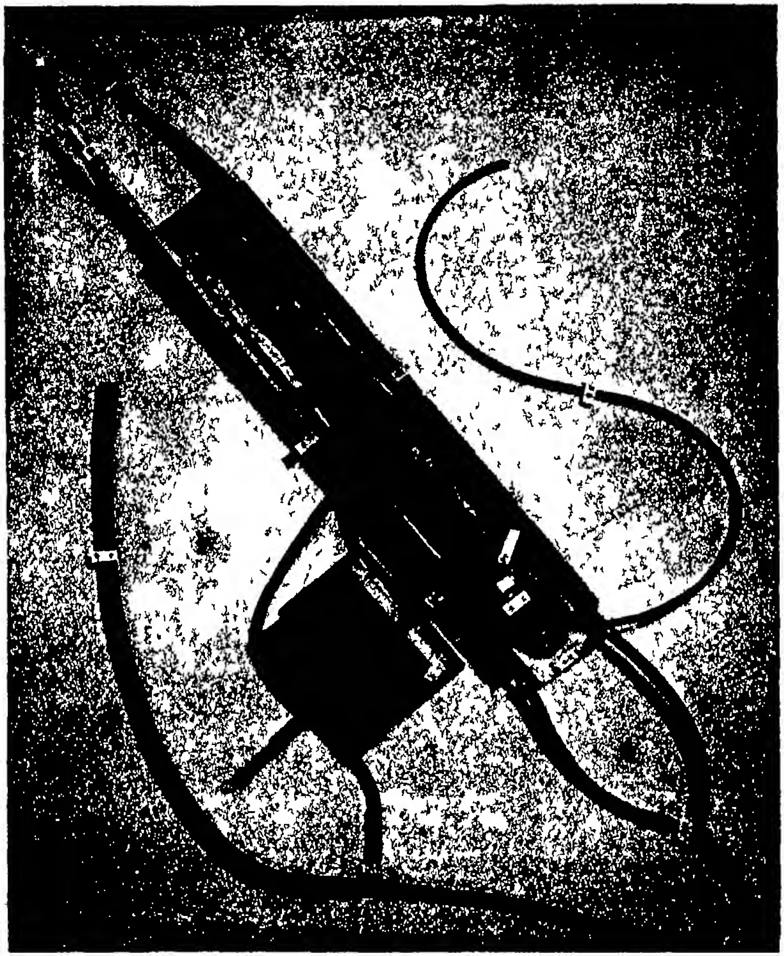


FIG 13 This figure illustrates arrangement of apparatus for determining the influence of the vago-sympathetics on gastric activity in Necturus TWF, rubber tube from water faucet, TT, glass T-tubes, WT, water-troughs for lower portion of gills, AH, animal-holder, OT, outlet tubes, TM, tube to manometer with balloon attached at opposite end, the latter being introduced into the stomach through a stomostomy opening in the floor of the mouth (not shown), CTTG, curved T-tube to keep upper portion of gills moist, IV, incisions for vagi, ITC, incision for transecting cord, Th, thermometer, L, ligatures attached to vago-sympathetics, S, support for apparatus, C, clamp to regulate flow of water through tubes

is contrary to that which exists in the stomachs of higher animals, although it has been shown by Hopf (9) for the frog and Bercovitz and Rogers (10) for the turtle that the tenth nerve contains both motor and inhibitory fibers to the stomach with the motor type predominating at least in the frog

The method used for the study of this problem consisted in transecting the spinal cord between the first and second cervical vertebra under either anaesthesia followed immediately by a stomostomy operation (11) near the angle of the mandible, for the introduction of the rubber balloon into the stomach via mouth and esophagus, for the recording of the gastric contractions (See Fig 13) The vagi were isolated dorsally and near

A

B

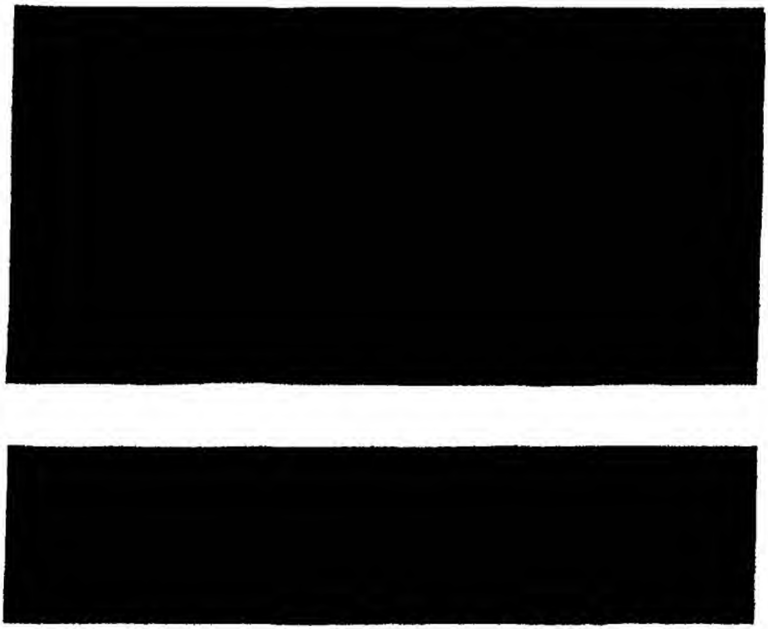


Fig 14. Movements of the empty stomach of Necturus before and after double vagotomy A, normal contractions with the vago-sympathetic nerves intact, B, contractions from the same animal's stomach after section of both vago-sympathetic nerves Note the augmentation of the contractions due to the removal of the inhibitory influence Straight line below curves = 0 mm. pressure of water manometer Time in five second intervals.

their exit from the cranium for a distance of 3 to 5 mm and lifting ligatures were placed under each nerve These nerves can be isolated without hemorrhage The incisions were plugged with cotton moistened with normal saline and the animals, dorsal side up, were placed on a specially constructed animal-holder with water-troughs, whereby the gills were constantly covered with running water, both from above and below Respiration and circulation are fairly normally maintained for periods ranging from three to five days, during which time the effect of the vago-sympathetics on the stomach can be determined (See Fig 14)

Stimulation of the vago-sympathetic, even slight traction, produced inhibition or stoppage of the movements of the empty stomach (See Fig 15) Ligaturing and sectioning of both vago-

Fig 15 Inhibition of the gastric movements in Necturus. (Same animal as in Fig 14) At X, slight traction on the peripheral end of the left vago-sympathetic nerve, producing practically a temporary standstill of the gastric contractions

sympathetics first produced inhibition of the gastric movements due to mechanical stimulation followed in a short time by the return of the gastric contractions in augmented form, the augmentation even greatly exceeding the normal contractions with the nerves intact These findings tend to show, that the fibers contained in the vago-sympathetics and destined for the stomach in the Necturus are largely inhibitory Evidence so far obtained also seems to indicate that the vago-sympathetics contain both motor and inhibitory fibers to the stomach, with the inhibitory type predominating The predominance of the inhibitory fibers is apparently in inverse order to the arrangement of these fibers as found in other animals

Detroit College of Medicine and Surgery
Detroit, Michigan

REFERENCES

1 Boldyreff Arch des Sci Biol, XI (1905), 1

2 Cannon and Washburn Am Journ Physiol, XXIX (1912), 441

3 Carlson The Control of Hunger in Health and Disease, Chicago, 1916

4 Patterson Am Journ Physiol, XLII (1916), 56

5 Patterson Am Journ Physiol, LIII (1920), 293

6 Patterson Am Journ Physiol, LIV (1920), 153

7 Patterson Am Journ Physiol, LV (1921), 283

8 Patterson Am Journ Physiol, LXIII (1923), 420

9 Hopf Zeitschr f Biol, 55 (1910–1911), 409

10 Bercovitz and Rogers Am Journ Physiol, LV (1921), 323

11 Patterson Journ Lab and Clin Med, V (1920), 674

OBSERVATIONS ON THE KAHN PRECIPITATION TEST

ELSA T SCHUERREN

THE opportunity presented itself in the laboratories of the Detroit Department of Health, in conjunction with the Health Department clinics, to study the clinical value of the Kahn Precipitation test as well as its serological comparison with the Wasserman test

As is well known, Kahn has recently modified his precipitation test procedure to a degree where it possesses several important advantages over the earlier method In the first place, the test as now performed is quantitative in a relative degree, consisting of three different serum-antigen proportions What is perhaps more important, is the elimination of the necessity for incubation, enabling the results to be read within several minutes after mixing serum with antigen Finally, the test is now sufficiently standardized to assure uniformity of results in the hands of different workers

In view of these advantages inherent in the test, it seemed desirable to undertake a study of the method, both in connection with the clinical material available as well as in comparison with the Wasserman test

The clinical material at hand for this study may be divided into two sets of cases, those diagnostic in character and those undergoing treatment Although the largest percentage of diagnostic cases are apparently normal individuals, a considerable number suffer from diseases other than syphilis Our findings thus may give evidence on the behavior of this test in various non-syphilitic diseases, particularly infectious diseases We also had occasion to examine a considerable number of sera from pregnant women

Of particular interest, especially in comparison with the Wasserman test, is our study of cases undergoing treatment In the Health Department Venereal Disease Clinic there are, on the average, four hundred and fifty patients under treatment for syphilis, constantly The determination of the relative sensitiveness of the Wasserman test and of the Kahn Precipitation test should prove of special value

Our general procedure may be briefly outlined as follows Blood specimens reaching our laboratory on any given day are centrifuged, serum separated in the usual manner and inactivated for twenty minutes Each serum is then examined with a Wasserman test in which two antigens are employed, a plain alcoholic extract and one which is reinforced with 2% cholesterin The fixation period is four hours in the refrigerator The Kahn Precipitation test is carried out according to the standard technique followed in the Michigan Health Department laboratories After the proper serum quantities are mixed with the three varying amounts of carefully prepared antigen mixture, the racks are shaken two minutes, salt solution is added and the results are read and recorded The final result in each test is the average finding in the three tubes

It should be stated in this connection that, through the courtesy of Drs Young and Kahn, antigen was supplied to us by the State Health Department laboratories Sera from selected cases were also sent to the State' laboratories as a special check on our findings

Kahn tests		Wass. pos	Wass doubtful	Wass negative
Positive	644	559	26	59
Doubtful	167	31	53	83
Negative	1213	15	12	1186

Complete check	1789	or	88 8%
Relative check	152	or	7 5%
No check	74	or	3 6%

A total of 2,024 examinations was made with both Wasserman and Kahn methods Of this number there were 559 positive with both tests, 53 doubtful with both, and 1186 in which both tests were negative, 88.8% thus checked completely For

the sake of simplicity we include four, three and two plus reactions as positive One hundred and fifty-two specimens or 7 5% of the total gave what we might term a relative check, that is, one test gave a positive or negative reaction and the other a one plus or doubtful reaction, 3 6% of the total number or the remaining 74 specimens did not check, that is, one gave a positive and the other a negative reaction The clinical histories of the cases giving us these discrepancies in results should prove the most interesting

Seven such cases which gave a negative Wasserman and positive Kahn were from the Department of Health Pre-natal Clinic Five of them were definitely diagnosed syphilis with positive histories The other two cases have not been diagnosed as syphilis, but one of them has been checked for a repeat specimen to be taken the next time the patient comes to the clinic In two instances of negative Wasserman reports and positive with Kahn, provocative KI was administered and then another sample taken One which had given a negative Wasserman and Kahn 2 3 3, gave a chol ant +++, alc ant —, and Kahn 3 4 4 after KI administration The other has an interesting history She had three apparently healthy children, the next died at the age of one week, since which she has had 6 miscarriages During this, her eleventh pregnancy, her Wasserman report was negative and Kahn 3 3 3 After KI her Wasserman was still negative and Kahn test was 2 2 2

For lack of time not many histories from the Venereal Clinic could be looked up, but of twenty cases which did not check in which the precipitation procedure gave a positive result with negative Wasserman, eighteen were treated cases, in which a positive diagnosis had been made and which had previously given four plus Wasserman reactions, showing that the Kahn method in these instances gives a more sensitive serological finding than does complement fixation The other two cases were diagnosed as negative syphilis and have not to date returned to our clinic

The case of a Miss X , a police case, was upon entrance on the tenth of December, diagnosed as clinical syphilis, symptoms charted were inguinal adenitis and ulcer on posterior vaginal

wall A blood specimen was drawn on day of admittance and one Salvarsan and two mercuries administered during the first week The Wasserman report was negative, which gave the Health Department no authority to quarantine such a police case On the second of February the Wasserman was again negative, as it was also on the fifth of March On specimen submitted on the last named date, however, a Kahn test was made which gave a 3 4 4 Kahn result Also further data on patient's chart says "Ulcer not healed"

Of the two hundred specimens submitted to the Lansing laboratory there was but one real discrepancy, six relative checks and 193 complete agreements, which gives the two laboratories a check of 98 5% on each other for both methods This one discrepancy, Mr Y, has the following history Case referred to Health Department by city physician's office stating patient had + + + + Wasserman Patient says he had syphilis twenty years ago Lansing reported a complete negative and Detroit Health Department an AC Wasserman and 4 4 4 Kahn Patient has been started on a course of treatment

Besides the data submitted, it might also be mentioned that during the three months in which this work was being done twenty-five samples gave an anti-complementary reaction with the routine Wasserman On these, the Kahn method gave twenty-two positive and three negative results Where enough serum was left a titrated Wasserman was done with increasing amounts of complement, such as is necessary to obtain true results with anti-complementary sera, and in all such cases the result agreed with the Kahn method

SUMMARY

The Kahn Precipitation test possesses several outstanding features which should prove helpful in the correct serum diagnosis of syphilis

1 The employment of these different proportions of serum and antigen renders the test not only quantitative in character to quite an extent, but the finding in each tube serves as a check

on the other two and thus increases the reliability of the final results

2 The rapidity with which a complete test may be executed renders it particularly valuable in such cases in which the obtainment of an immediate diagnosis is of paramount importance, as, for example, in cases of blood transfusion or in the collection of serum from convalescent scarlet fever cases

3 It eliminates the use of such variable factors as guinea pig complement and sheep cells, and is in this respect less subject to error than the Wasserman test

4 The test according to our findings gives evidence of being specific for syphilis and appears to be slightly more sensitive than the Wasserman test

DEPARTMENT OF HEALTH
DETROIT, MICHIGAN

X-RAYS AND THE FREQUENCY OF NON-DISJUNCTION IN DROSOPHILA *

E G ANDERSON

THE work of Mavor (1922, 1923) on the effects of X-rays on *Drosophila melanogaster* has shown a method of producing primary non-disjunctional exceptions more or less at will This method has been utilized by the writer in an effort to throw some light on the interrelations of crossing-over and non-disjunction These experiments are still in progress In part of the tests frequency tabulations have been made for regular and exceptional offspring The data obtained are incidental to the main purpose of the experiment, but serve to confirm the results of Dr Mavor

A preliminary test was made at the College of the City of New York during the spring of 1923, the X-ray treatments being administered by Dr Edwin G Taylor of the Physics Department of that institution A seven-inch Coolidge tube was operated at a potential of 30,000 volts and a current of 3 milliamperes The average exposure was about twenty-five minutes at a distance of seven inches from the target The flies treated were virgin F_1 females from a cross of scute apricot cross-veinless tan forked females by broad echinus cut garnet males The treated females were mated to Bar males Forty-two fertile cultures were counted, giving a total of 6940 offspring These consisted of

3577	regular (heterozygous Bar)	females,
3289	regular (not Bar)	males,
10	exceptional (not Bar)	females,
64	exceptional (Bar)	males

* Paper from the Department of Botany of the University of Michigan, No 207, reporting research conducted by the author while holding appointment as National Research Fellow in Biology

The paper was presented before the Section of Botany as one of a group dealing with genetical problems.

Recent tests made at the University of Michigan have involved a larger number of individuals Echinus cut garnet females were crossed with scute cross-veinless vermilion forked males Virgin F_1 females were rayed within twenty-eight hours after emergence The X-ray treatments were administered by Dr S MacFarland at the University Hospital A Wappler Roentgen Apparatus was used with a potential of about 70,000 volts and a current of 5 milliamperes The flies were exposed for ten minutes at a distance of seven inches from the target After treatment they were mated with yellow forked Bar or yellow scute cross-veinless Bar males The progeny of several sets of cultures were counted The results were

18414	regular (Bar)	females,
16828	regular (not Bar)	males,
73	exceptional (not Bar)	females,
397	exceptional (Bar)	males

The percentages of exceptions obtained are given in the following table The percentages obtained by Mavor (1923) are included for comparison

	Total number of females	Percentage of exceptions	Total number of males	Percentage of exceptions
Preliminary test	3587	0 3	3353	1 9
Later tests	18487	0 4	17225	2 3
Mavor (1923)	3960	0 4	3575	2 3

The percentages of exceptions obtained from flies which have not been X-rayed are very much lower The following table gives the percentages obtained in untreated cultures from data published by Safir (1920) and by Mavor (1923)

	Total number of females	Percentage of exceptions	Total number of males	Percentage of exceptions
Safir w^e m	25021	0 07	22524	0 31
Safir other tests	68353	0 02	64124	0 10
Mavor (1923)	12698	0 02	12648	0 06

The eosin miniature used by Safir gave unusually high percentages of exceptions The values obtained in all his other stocks and by Mavor are the usual ones

Primary non-disjunction has been shown to occur in *Drosophila melanogaster* with a fair degree of regularity although the frequency of its incidence is very low (Bridges, 1916, Safir, 1920, Mavor, 1922, 1923) The normal expectation is about one exception per 4000 females and one exception per 1000 males Since one half of the exceptional eggs fail to give viable offspring, the actual frequency of primary non-disjunction is double the frequency of the observed exceptions The effect of X-ray treatment is to increase the frequency about twenty-fold The exceptions produced are probably not different from those produced normally without X-ray treatment

University of Michigan

LITERATURE CITED

Bridges, C B 1916 Non-disjunction as Proof of the Chromosome Theory of Heredity Genetics, 1 1–52, 107–163

Mavor, James W 1922 The Production of Non-disjunction by X-rays Science, 55 295–297

—— 1923 X-rays and the Sex Chromosomes Science, 57 503–504

Safir, Shelley R 1920 Genetic and Cytological Examination of the Phenomena of Primary Non-disjunction in *Drosophila melanogaster* Genetics, 5 459–487

THE FORMS OF CARPHOPHIS *

FRANK N BLANCHARD

KENNICOTT[1] in 1859 proposed names for two new forms of snakes of the genus Celuta (now Carphophis), a genus hitherto known only from the eastern states and Mississippi A specimen from Missouri he named *C vermis*, and one from Monticello, Mississippi, with three from Southern Illinois, *C helenae* The former has since been adjudged by most authors to be a good form, but largely because of Cope,[2] *C helenae* has been generally regarded as an individual variation of the well known *C amoena* *C helenae* was based upon the presence of only two large plates on top of the head anterior to the frontal plate, instead of two prefrontals and two internasals, as in *C amoena* and in *C vermis* The fusion of these plates has since been noted at various times in additional specimens, but this feature has not been observed to be correlated with any other distinctive characters nor with any geographic region

Hurter,[3] however, in 1911, sorted his specimens roughly according to locality and noted that the fusion of internasals with prefrontals characterized his specimens from Mississippi, Tennessee, Kentucky and Illinois, but his series was too small to attract notice and he himself attached no special significance to the fact

It is the purpose of the present discussion to show that this fusion of internasals with prefrontals is highly characteristic of snakes of this genus in the whole region between the Mississippi River and the Appalachian Mountains, and that their subspecific separation from their relatives in the eastern states is justified

* Contribution from the Zoölogical Laboratory of the University of Michigan

[1] *Proc Acad Nat Sci, Philadelphia*, 1859, pp 99, 100

[2] *Rept. U. S Nat Mus for 1898*, p 735 1900

[3] *Trans Acad Sci St Louis*, Vol 20, No 5, p 194.

Of seventy-seven specimens[4] examined from the Atlantic states from Connecticut through Georgia, seventy-five had the internasals separate from the prefrontals, one from Clarke County, Virginia (U S N M, No 1873), had them fused, one, from Augusta, Georgia, had them fused (U S N M, No 8792, and one, from Blue Ridge, North Carolina, had the internasal and prefrontal fused on the right side and separate on the left In these states, therefore, the percentage of instances in which these plates are separated is 97

From Illinois, Indiana, Ohio, Kentucky, Tennessee, Alabama and Mississippi, data on the internasals are at hand for ninety-three specimens These data are derived from personal examination of eighty-four specimens and definite published accounts of nine others Twenty-three of these come from the eastern limits of this group of states twenty-one from northeastern Alabama and eastern Tennessee, one from an undetermined locality in Kentucky (Creek Gap, M C Z, No 3828), and one from "Ohio" Of these twenty-three, twelve have the internasals separate, and eleven have them united with the prefrontals From this fact and from their locality they may be regarded as "intergrades" and omitted from the next discussion Of the seventy specimens remaining, four have the internasals well-developed, three have them separate but unusually small, one has the left internasal separate but very small, while the right internasal is mostly fused with the right prefrontal, and sixty-two have the internasals completely united with the prefrontals This gives a constancy of 89 per cent in the fusion of these plates for all specimens east of the Mississippi River and west of the Appalachians

A constancy of 89 per cent in a character differentiating two closely allied forms is quite satisfactory Compare with this the following percentages of constancy in characters differentiating the two eastern races of Carphophis from the western race These figures are based upon thirty-one specimens of *C vermis*, ninety-four of *C amoena*, and fifty-three of *C helenae*

[4] Two specimens listed by Cope as "form helenae" are *C. amoena*,— U S N M, Nos., 12128 and 19488. (*Rept U S Nat. Mus for 1898*, p. 737 1900 Cope's number 19488 is a misprint for 19484)

TABLE SHOWING DIFFERENTIATION OF TWO EASTERN SPECIES OF CARPHOPHIS

Name of form	Character	Percentage of constancy
amoena	2 post temporal scutes	88
helenae	2 post temporal scutes	80
vermis	1 post temporal scute	94
amoena	Light color extending onto first or second row of dorsal scales	100
helenae	Light color extending onto first or second row of dorsal scales	98
vermis	Light color extending onto the third row of dorsal scales	70

The separation of *C vermis* from *C helenae* and *C amoena* based on the numbers of ventral scutes is also incomplete, for while the averages are distinctly different, the ranges of variation in the females broadly overlap This is shown in the following table

TABLE SHOWING NUMBERS OF VENTRAL PLATES IN FORMS OF CARPHOPHIS

NAME OF FORM	MALES			FEMALES		
	No of specimens	Extremes	Averages	No of specimens	Extremes	Averages
amoena	33	113–128	121	39	122–140	131
helenae	24	113–127	118	25	122–137	128
vermis	12	127–135	131	18	129–142	137

It thus appears that the distinction between *C helenae* and *C amoena* is as constant as that between either of these and *C vermis* The only difference is that only one character is at present known to mark off *C amoena* from *C helenae* The writer does not regard this as sufficient reason for not recognizing the

latter as a form separate from *C amoena* Furthermore, the writer believes it probable that other differentiating characters will yet be found, and would call special attention to the fact that the table above is based upon a fair number of specimens of each sex of *C amoena* and of *C helenae*, and that each sex of *C helenae* has an average of three ventrals fewer than the corresponding sex of *C amoena*

In summary, evidence has been brought forward to show that the *Carphophis amoena* of present conception comprises two recognizably distinct geographic races or subspecies, *C amoena amoena* of the Atlantic Coast and eastern Appalachian Mountains, and *C amoena helenae* of the region from the western Appalachians to the Mississippi River

Appended is a diagnosis of the subspecies of Carphophis

a_1 Color above generally brown, light color of belly extending onto first or second row of dorsal scales, commonly two temporal scutes behind the first

b_1 Internasals and prefrontals usually separate *C amoena amoena* (Say) (Connecticut and Albany County, New York, south to central Florida and west into the Appalachian Mountains)

b_2 Internasals and prefrontals usually united into two large shields *C amoena helenae* (Kennicott) (From central Illinois south through Mississippi and east to northwestern Alabama, the Tennessee valley in eastern Tennessee and eastern Ohio)

a_2 Color above generally gray or black, light color of belly extending usually onto the third row of dorsal scales, commonly a single temporal scute behind the first *C amoena vermis* (Kennicott) (Southeastern Nebraska and central Missouri south through eastern Oklahoma, Arkansas, and Louisiana)

The writer is under continued obligation to numerous museums and curators for cordial welcome to their collections During the course of the present study specimens have been examined from the United States National Museum, the Museum of Comparative Zoölogy, the American Museum of Natural History, the Museum of Zoölogy of the University of Michigan, the Zoölogy Department Museum of Cornell University, and the Museum of Kansas University

UNIVERSITY OF MICHIGAN

A NAME FOR THE BLACK PITUOPHIS FROM ALABAMA *

FRANK N BLANCHARD

FOUR years ago I reported [1] the finding in Mobile County, Alabama, of a black bull-snake (Pituophis) by Mr H P Loding of Mobile This was found dead early in June, 1919, on the "Hall's Mill Road, in the vicinity of high, sandy hills, near Hall's Mill Creek, Abott's Station, about 14 miles southwest of Mobile" I also reported a second specimen taken alive by Dr E D King, Jr, at Grand Bay, 26 miles southwest of Mobile This also was taken in 1919, on July 24 or 25 This specimen I have since seen and it is in all essential respects like the first, except that the throat is immaculate white instead of black

On July 28, 1920, Mr Loding took a third adult black bull-snake at Irvington, a location half-way between the former two This has been deposited in the Alabama Natural History Museum at University, Alabama

On April 30, 1924, Mr Löding secured a fourth adult black bull-snake in the same general region as the other three

The territory over which these four specimens have been taken, Mr Löding writes, consists now mostly of Satsuma orange and pecan orchards, but was formerly fairly high and dry pine lands

The finding of these four isolated specimens of black bull-snakes and the absence of other records of Pituophis from the states of Georgia, Alabama, Mississippi and Louisiana are sufficient evidence of a need for a name to designate this Alabama

* Contribution from the Zoölogical Laboratory of the University of Michigan

[1] *Copeia*, No 81, p 30

form In honor of its discoverer I propose for it, therefore, the name

Pituophis lodingi, new species

Diagnosis —Similar to *Pituophis melanoleucus* (Daudin), but almost entirely black above and below

Type specimen —Museum of Zoology, University of Michigan, number 58800, collected by H P Loding between Irvington and Grand Bay, Mobile County, Alabama, April 30, 1924

Description of type specimen —Ventrals, 215, anal, single and entire, 65 divided caudals, upper labials, 8 on each side, lower labials, 15 on each side, one preocular on each side, 4 postoculars on each side, 4 temporals in the first row, rostral dividing the internasals for three-fourths of their length, maximum number of scale rows, 29 (27 rows for a short distance anteriorly, and 21 rows at the posterior end), keels on dorsal scales prominent above, progressively fainter on the sides, descending as low as the sixth row anteriorly and the third row posteriorly Total length, 1563 millimeters, tail length, 261 millimeters Sex, male

The coloration (by reference to Ridgway's *Color Standards and Nomenclature*) is as follows Above, a glossy black, below slate color, most of the gular and lower labial scales somewhat flecked with a dark shade of cinnamon

Further specimens of Pituophis from this region will be awaited with interest

UNIVERSITY OF MICHIGAN

A COLLECTION OF AMPHIBIANS AND REPTILES FROM SOUTHEASTERN MISSOURI AND SOUTHERN ILLINOIS *

FRANK N BLANCHARD

THE following collection was made in the course of an automobile trip in June, 1923, to the so-called "Sunken Lands" of Missouri, and to the hilly country of southern Illinois

The low lands of extreme southeastern Missouri have already been largely reclaimed from the Mississippi River by levees and drainage ditches Deforestation, ditching and farming are altering totally the nature of the country and its animal inhabitants In the part of southern Illinois most particularly covered, Johnson County, there are still some forests and much uncultivated country The rugged and picturesque aspect of this region changes completely and abruptly between Ozark and New Bernside From hilly farming country with small rural communities and unimproved roads, one enters northward a nearly level mining region of far less natural attractiveness

The region covered by this collection is the meeting ground of many northern and southern species and ought to be thoroughly studied before the natural conditions have been further changed

All the specimens in this collection have been deposited in the Museum of Zoölogy of the University of Michigan

LIST OF SPECIES

PLETHODON GLUTINOSUS (Green) — Four adults and three young ones (58747) were collected four miles south of Ozark,

* Contribution from the Zoölogical Laboratory of the University of Michigan

Illinois, in Johnson County, June 21 They were in a well-wooded ravine formed by a permanent stream One adult was under a large, rotten log, one juvenile was near or on the roots of a plant, the others were taken under damp, flat stones under overhanging ledges of rock Another, a juvenile (58748), was taken in the same county about 20 miles north of Metropolis, on June 20 This one was under a small log near the base of a dry wooded slope

EURYCEA LONGICAUDA (Green) — Two adults (58749–50) were taken along with several *Plethodon glutinosus* under flat, wet stones, under overhanging ledges, in a wooded ravine, 4 miles south of Ozark, Johnson County, Illinois, June 21

BUFO FOWLERI Garman — The peculiar song of this toad was heard at dusk and shortly after dark at Evansville and Cairo, Illinois, and at Jackson and Portageville, Missouri One specimen was collected at each of the following places (58767–70) 4 miles south of East Cape Girardeau, Missouri, June 18, 20 miles north of Metropolis, Johnson County, Illinois, June 20, 2 miles southeast of Portageville, Pemiscot County, Missouri, June 16 In the small town of Portageville, Missouri, on June 16, many of these toads were calling shortly after dark By means of a flash-light nineteen males and two females were collected here in a shallow pond in a vacant lot between houses This toad, on every occasion lived up to its reputation for being more active and harder to catch than *B americanus*

ACRIS GRYLLUS (Le Conte) — Two (58751) were taken at a small roadside cattail pond in Johnson County, Illinois, 20 miles north of Metropolis, June 20 In Pemiscot County, Missouri, it was exceedingly common Eleven specimens (58752) were collected along the grassy margin of a brushy lake, 10 miles southeast of Portageville, June 16

HYLA VERSICOLOR VERSICOLOR (Le Conte) — Near Evansville, Randolph County, Illinois, the Hylas began to call, at dusk and after dark, on June 13, near a small muddy pond in a depression surrounded by trees I sought them with flash-light, and, by diligent search, following the calls, collected four males They were all within a few inches of the water on the ground.

Apparently none were back in the trees, although a few may have been in the pond It was astonishingly hard to find them even when very close Later in the evening they did not sing at all

RANA CATESBEIANA Shaw — One adult (58753) was taken at the shady margin of a small cattail pond by the roadside, 20 miles north of Metropolis, in Johnson County, Illinois, June 20

RANA CLAMITANS Latreille — Three individuals, a small one (58759) and two adults (58760-1), were taken in a brushy lake near the Mississippi levee 10 miles southeast of Portageville, Pemiscot County, Missouri, June 16 and 17

RANA SPHENOCEPHALA Cope — This frog was seen frequently, but not in numbers Two (58755) were collected 10 miles southeast of Portageville, Pemiscot County, Missouri, June 17, another (58756) was taken 2 miles southeast of Portageville June 16, an adult (58762) was collected 4 miles south of Ozark in Johnson County, Illinois, June 21, a small one (58757) was taken 10 miles northwest of Chester, in Randolph County, Illinois, June 13, an adult (58758) was taken 3 miles north of Redbud, Monroe County, Illinois, June 12 The last was in thick vegetation at the edge of a thick woods, 50 feet from a stream It was plain dull green above, except for the cream-colored lateral folds and the spots

RANA SYLVATICA Le Conte — A single adult (58754) was found in thick woods near a stream, 3 miles north of Redbud, Monroe County, Illinois, June 12

SCELOPORUS UNDULATUS (Latreille) — Four specimens were taken, as follows one female (58743) 3 miles north of Redbud, Monroe County, Illinois, June 12, and a small male (58744) at the same place the next day, an adult male (58745) in Massac County, 4 miles northwest of Metropolis, Illinois, June 19, on a log in a piece of woods, an adult female (58746) in Johnson County, Illinois, about 20 miles north of Metropolis, June 20

EUMECES FASCIATUS (Linné) — Six individuals were secured, as follows one small one (58737) on a fence in a farm-yard, 3 miles north of Redbud, Illinois, June 13, one large male (58738) with red head found sunning himself on a rock on a river bluff about 10 miles northwest of Chester, Randolph County, Illinois,

one small one (58739) 3 miles southeast of Portageville, Missouri, June 17, two small ones (58740–1) 10 miles southeast of Portageville, Pemiscot County, Missouri, and one small one (58742) in Johnson County, Illinois, about 20 miles north of Metropolis, June 20.

HETERODON CONTORTRIX (Linné).—One small adult male (57718) was taken while crossing a road at midday about 4 miles north of Perryville, Perry County, Missouri, June 14. The ventral plates number 131, caudals, 44, upper labials, 8, lower labials, 10, total length is 522 mm., tail length, 97 mm.

COLUBER CONSTRICTOR CONSTRICTOR (Linné).—Two adults were found in a wooded ravine in Johnson County, Illinois, about 4 miles south of Ozark, on June 21. Their scutellation is as follows:

No.	Sex	Scale rows	Ventrals	Caudals	Labials	Total length	Tail length
58716	female	17–19–15	179	83	$\frac{7\ 7}{8\ 9}$	1319 mm.	304 mm.
58717	male	17–15	173	92	$\frac{7\ 7}{7\ 9}$	1210 mm.	323 mm.

In No. 58716 the scale rows become 19 for some distance along the middle of the body, by the addition of scales adjacent to the median dorsal row.

ELAPHE OBSOLETA OBSOLETA (Say).—Five specimens were taken, as follows: A half-grown individual (58732) was found lying at full length on the ground in heavy oak woods, 3 miles north of Redbud, Monroe County, Illinois, June 13. It made no attempt to escape and was gentle to handle. This shows a pattern of dorsal blotches for a little more than half the body length. On the remaining specimens no pattern is visible, except faintly on the anterior portion of the body of 58736. Near the same place in which 58732 was taken, a large adult (58733) was found on a fence by a farm-house, coiled along the middle rail. A large male (58734) was found recently dead in the road 7 miles north of Perryville, in Perry County, Missouri, June 14. A moderate-sized female (58735) was found in the road in Cape Girardeau County, 2 miles north of Jackson, Missouri, on the same day as

the last On June 18 a small adult male was found in the road early in the morning in Scott County, about 12 miles south of Cape Girardeau, Missouri

Measurements and scutellations of these specimens are as follows

No	Sex	Scale rows	Ventrals	Caudals	Labials	Total length	Tail length
58732	female	25-17	232	73	$\frac{8\ 8}{13\ 13}$	715 mm	116 mm
58733	female	25-27-19	231	63	$\frac{8\ 8}{13\ 12}$	1456+ mm	215+ mm
58734	male	23-25-17	241	81	$\frac{8\ 8}{11\ 11}$	1835 mm	305 mm
58735	female	25-27-19	235	76	$\frac{8\ 8}{12\ 12}$	1330 mm	217 mm
58736	male	25-26-17	233	84	$\frac{8\ 8}{11\ 11}$	1152 mm	205 mm

ELAPHE OBSOLETA CONFINIS (Baird and Girard) — Two examples of *Elaphe obsoleta*, the only ones taken in the "Sunken Lands" of Missouri, show a distinct pattern of dorsal blotches unlike the series of six taken elsewhere (except for one juvenile of the latter group) Both were taken in Pemiscot County,— one (58730), in some bushes at the edge of an overflow from a drainage ditch about 2 miles southeast of Portageville, the other (58731), at the edge of a ditch in the shade of bald cypress beside the levee The first has 28 dorsal blotches on the body and the second has 32

Following is their scutellation

No	Sex	Scale rows	Ventrals	Caudals	Labials	Total length	Tail length
58730	female	25-19	233	74	$\frac{8\ 8}{11\ 11}$	1024 mm	177 mm.
58731	male	25-27-19	229	78	$\frac{8\ 8}{11\ 11}$	1700 mm	286 mm.

NATRIX ERYTHROGASTER (Forster) — Two adults were discovered mating among the grass and weeds at the edge of a

swampy area adjoining a drainage ditch, a little before noon of a sunny day, June 16 Both were secured and kept alive in a cloth until the return to Ann Arbor, Michigan, June 25 They were transferred to a cement enclosure out of doors, and several large frogs (*Rana pipiens*) were thrown in with them The snakes were very active, and each immediately swallowed two frogs During the remainder of the summer the snakes were rarely seen unless hunted for Then they would be found coiled, generally separately, under the sods and leaves The object in keeping them alive was to obtain young ones, but none appeared The snakes were transferred to a cool room indoors in late autumn, but were found dead in January

In both snakes the uniform dark dorsal color extended without interruption down the sides and well onto the ends of the ventral plates Below, the female was greenish-yellow anteriorly, with a good deal of pink in the middle and posteriorly, and the male was pale greenish-yellow over the whole lower surface The ventrals of both were flecked with dark at their bases, except towards the head

The body length, measured alive, was about 785 mm in the male and 770 mm in the female Each individual lacked the tip of the tail They were found in Pemiscot County, Missouri, about 1 mile south of Portageville

Their scalation is as follows

No	Sex	Scale rows	Ventrals	Labials
58723	male	23-21-23-17	150	8 8 / 10 10
58724	female	23-21-23-17	149	8 8 / 10 10

NATRIX FASCIATA CONFLUENS Blanchard — One small female was taken at the edge of an area of brushy overflowed land at the edge of the Mississippi levee in Pemiscot County, 10 miles southeast of Portageville, Missouri, June 17 It is in every respect typical of this subspecies as recently described, and is quite within the known range. There are about 14 dorsal saddles on the body

No	Sex	Scale rows	Ventrals	Caudals	Labials	Total length	Tail length
58725	female	23–17	137	64	$\frac{8\ 8}{10\ 11}$	322 mm	74 mm

NATRIX RHOMBIFERA (Hallowell) — Two examples were taken in Pemiscot County, Missouri, on June 17, a large one about 10 miles southeast of Portageville and a small one about 7 miles southeast of Portageville The first was taken from under a large board in a very small stream of flowing water near the Mississippi levee, the other was found resting on water weeds in a ditch among bald cypress

Scutellation and measurements follow

No	Sex	Scale rows	Ventrals	Caudals	Labials	Total length	Tail length
58719	male	25–27–21	143	78	$\frac{8\ 8}{12\ 12}$	979 mm	255 mm
58720	male	25–28–21	144	71	$\frac{8\ 8}{11\ 11}$	374 mm	91 mm

NATRIX SIPEDON SIPEDON (Linné) — A small one was taken in a muddy stream near overhanging vegetation in Monroe County, 3 miles north of Redbud, Illinois, on June 12 The half-circular marks on the ventral scales are typical Along the middle of the belly was a stripe of bright brick-red The dorsal pattern is a little atypical in that the dark saddles, 23 in number, are complete on the sides throughout the body length, with no lateral alternating spots

In Johnson County, Illinois, about 20 miles north of Metropolis a moderate-sized individual (58722) was taken, June 20, in the grassy margin of a small, cattail pool by the roadside, far from any other water Its pattern is a little peculiar There are only 22 dorsal saddles on the body and they are nearly all continuous down the sides Furthermore, they are mostly a brick-red in life, darker above and brighter on the sides, and the half-circular markings on the ventral plates were also bright reddish, becoming mixed with black posteriorly

Measurements and scutellation follow

No	Sex	Scale rows	Ventrals	Caudals	Labials	Total length	Tail length
58921	male	23-17	142	75	$\frac{8\ 8}{10\ 10}$	293 mm	78 mm
58922	female	23-17	141		$\frac{8\ 8}{11\ 10}$	825+ mm	148+ mm

THAMNOPHIS SAURITUS PROXIMUS (Say) — Four individuals were secured One (58726) had been recently killed in the road 6 miles north of New Madrid, in New Madrid County, Missouri, June 17 The others were found June 16 and 17 in open grassy places adjoining the overflowed lands by the Mississippi levee in Pemiscot County, Missouri, 10 miles southeast of Portageville

Scutellation and measurements follow

No	Sex	Scale rows	Ven-trals	Cau-dals	Labi-als	Total length	Tail length	Tail length divided by total length
58726	male	19-17	170	93	$\frac{8\ 8}{10\ 10}$	741 mm	207 mm	0 279
58727	male	19-17	174	100	$\frac{8\ 8}{10\ 10}$	598 mm	177 mm	0 296
58728	female	19-17	169	97	$\frac{8\ 8}{10\ 10}$	405 mm	123 mm	0 304
58729	female	19-17	173	105	$\frac{8\ 8}{10\ 10}$	813 mm	240 mm	0 294

THAMNOPHIS SIRTALIS PARIETALIS (Say) — One adult observed killed at roadside in Monroe County, Illinois, 3 miles north of Redbud, June 13

STERNOTHERUS ODORATUS (Latreille) — A small adult (58708) was picked up in the road 3 miles southwest of Carriers Mills, Saline County, Illinois, early in the morning on June 22

CHELYDRA SERPENTINA (Linné) — One (58714) with carapace 38 mm long was taken about 10 miles southeast of Portageville, Pemiscot County, Missouri, on June 16

TERRAPENE CAROLINA CAROLINA (Linné) — Two adults (58701-2) were taken in an open woods on a hillside in Johnson

County, Illinois, June 20, two half-grown individuals (58704–5) were found in a wooded ravine 4 miles south of Ozark in Johnson County, Illinois, June 21, one adult (58703) was taken on a shaded path through woods 4 miles south of East Saint Louis, Illinois, June 11, and one adult (58706) was taken 3 miles north of Redbud, Monroe Co , Illinois, June 12

TERRAPENE ORNATA (Agassiz) — One individual (58707) with carapace 70 mm long was taken 4 miles north of Redbud, in Monroe County, Illinois, June 12

CHRYSEMYS ELEGANS (Wied) — One individual (58711) with carapace 215 mm long was taken in Pemiscot County, Missouri, June 17, one (58712) with carapace 50 mm long was taken in the same county about 7 miles southeast of Portageville on June 16, and one (58713) with carapace 39 mm long was taken about 10 miles southeast of Portageville on June 17

CHRYSEMYS BELLII DORSALIS (Agassiz) — Two specimens were taken near the Mississipi levee about 10 miles southeast of Portageville, in Pemiscot County, Missouri One (58710) has a carapace 144 mm long and was taken on June 16, the other (58709), which was taken on June 17, has a carapace only 36 mm long

UNIVERSITY OF MICHIGAN

A LIST OF COLEOPTERA FROM CHARLEVOIX COUNTY, MICHIGAN *

MELVILLE H HATCH

In connection with a land and economic survey that was being conducted by the Department of Conservation of the State of Michigan in Charlevoix County in the summer of 1922, the author was engaged to investigate and report on the coleopterous fauna of the region With the publication of the report of the investigation, it seemed advisable to incorporate the results of a study of two other collections of Coleoptera that were available from the same county So that the material on which the present list of Coleoptera from Charlevoix County is based is derived from three sources (1) a collection of about three hundred and forty species made in the years 1919 to 1923 in the Beaver Islands by Mr Sherman Moore of Detroit, (2) the collection of about three hundred and five species made by the author on Beaver Island and on Garden Island and at Charlevoix, while in the employ of the Department of Conservation of the State of Michigan from August 22 to September 11, 1922, (3) a collection of about one hundred and thirty species made for the Department of Conservation of the State of Michigan and the University of Michigan Museum of Zoölogy by Mr T H Hubbell on Hog Island in July 1921 and at Thumb Lake, Boyne City, Boyne Falls, and Norwood Township between July 8 and August 6, 1923 This last collection was made incidental to a survey of the Orthoptera of the region A single species is included that was taken by Dr Frank N Blanchard of the University of Michigan at Nowland Lake in 1917 From this material the

* Published with the permission of the Director of the Department of Conservation of the State of Michigan, a contribution from the Zoölogical Department in the Liberal Arts College, Syracuse University

present list numbering five hundred and eighty species and five varieties has been compiled A few undetermined specimens still remain in the author's hands

The specimens on which the report is based are deposited in the University of Michigan Museum of Zoology and in the private collection of Mr Sherman Moore, duplicate specimens of many of the species have been placed in the private collection of the author

Acknowledgment is due to Mr Moore for the courtesy he has shown in rendering accessible the Charlevoix County specimens contained in his private collection, and for the help he has given in compiling the data on them, as well as for the information he has supplied concerning the conditions in the region The author is further indebted to the University of Michigan Museum of Zoology for permission to examine Mr Hubbell's specimens and notes, as well as other Charlevoix County Coleoptera in its possession

Further acknowledgment is due the following coleopterists for help in determining certain of the species Mr Howard Notman, Carabidae and Staphylinidae, Mr J B Wallis, Amarini, Dytiscidae and Gyrinus, Mr Henry Dietrich, Silphidae, Byrrhidae and Nitidulidae, Prof F E Blaisdell, Stenus and Hister, Dr A Fenyes, Aleocharinae, Mr Emil Liljeblad, Mordellidae, Dr Edward D Quirsfeld, Elateridae, Mr Frank C Fletcher, Tenebrionidae, Mr C A Frost, Pachybrachys, Mr L L Buchanan, Curculionidae, and Prof M W Blackman, Scolytidae In addition several of the determinations have been made by Mr A W Andrews, with whom Mr Moore has been associated in studying his material In every case the authority for the determination is indicated in parentheses immediately following the name of the species

Charlevoix County constitutes a portion of the mainland on the west shore of the Southern Peninsula of Michigan as well as the Beaver Islands, which have been attached to it for political and economic rather than for geographical reasons The Beaver Islands consist of nine islands lying in the northern end of Lake Michigan, from twelve to twenty miles from the neighboring

countries of Emmet and Mackinac They have been uncovered by the progressive lowering of the lakes that formed in the region following the retreat of the Wisconsin ice sheet, and so have never been connected with the mainland This has been no impediment to their occupation by a coleopterous fauna, which is, however, not surprising in view of the alate condition of that order The degree of isolation has, moreover, been insufficient to produce any local races, so far as the present investigations indicate

Beaver Island, the largest of the Beaver Island group, is twelve or fifteen miles long and from two to five miles wide Most of the author's specimens were taken in the vicinity of St James at the northern end of the island Portions of the island are sandy, supporting a growth of pine and juniper In other portions the soil is rich enough for farming operations as well as for an abundant growth of Solidago and other herbage There are cedar bogs, beach ponds, and other lakes and ponds Faunt Lake is a mile or so long Round Lake is a pond of extremely variable size In spring it is large, inundating the surrounding fields In summer it shrinks, exposing wide muck margins which support an abundant fauna of littoral Coleoptera

Garden Island is about one and one-half miles north of Beaver Island, being some five miles in length by two in width The interior is high and covered with hardwoods scattered through which are abandoned clearings There are also a few small lakes

Hog Island, three and one-half miles long by one mile wide, is three and one-half miles east of Garden Island The island is low and covered with a dense forest Collecting is possible only along the shore and is not good there

Hat Island, about fourteen hundred feet in diameter, is two and one-half miles east of Hog Island It is the breeding ground of a large colony of herring gulls and a smaller colony of Caspian terns

Squaw Island and Whiskey Island, which are about one and one-half miles apart, lie about three miles west of the north end of Garden Island They are about one-half mile in diameter The beaches are wide and stony, the interiors are covered with

a dense growth of small mixed timber, and from the northeast corner of each a long gravel spit extends into the lake

High Island, called Little Beaver Island on some of the earlier charts, is about four miles west of the north end of Beaver Island It is about four miles long and two miles wide The interior is high and covered with hardwoods, which contain numerous clearings of the Indians as well as a farm of two hundred acres

Trout Island is similar to Squaw Island and Whiskey Island and is about a mile and a half north of the northwest corner of High Island

Gull Island lies about seven miles west of the south end of High Island It is a mile long by half a mile wide The interior is a dense forest This island is the breeding-place for great numbers of herring gulls, and is overrun with rabbits which were introduced a number of years ago by fishermen

Through the channels between the island run currents which are sometimes of considerable strength As a result of these currents there is little beach drift Insects blown off the islands and falling into the lake are carried away, instead of being thrown up on the beach with a shift in the wind A small amount of drift occurs on the north end of Beaver Island, on the north end of High Island, on the northeast corner of Hog Island, and on the southeast corner of Gull Island In addition considerable beach drift was observed on the mainland on the Lake Michigan beach at Charlevoix and at Pine Lake near Boyne City

In the annotated list the following information is given for each of the species (1) the number used in the Leng Catalogue,[1] the nomenclature and sequence of which are followed, with a few exceptions, (2) the name of the species, followed by the authority for the determination in parentheses if he is other than the author, and by a question mark (?) if the determination is doubtful, (3) the number of specimens examined from the region, (4) the first and last dates on which specimens were taken,

[1] Leng, C W 1920 *Catalogue of the Coleoptera of America, North of Mexico* Sherman, Mount Vernon, N Y.

(5) the localities at which specimens were taken, (6) a brief citation of the habitat of the species 'Sweeping' refers to the collecting of specimens from non-woody plants herbage, weeds, etc 'Beating' refers to the collection of specimens from shrubs, bushes, and the lower branches of trees

CICINDELIDAE

49 CICINDELA DUODECIMGUTTATA Dej, 4, June 14 — Sept 5, Beaver Is, High Is, Garden Is, Thumb Lake, beach

50 CICINDELA REPANDA Dej, 23, June 21 — Aug 26, Beaver Is, Garden Is, High Is, Hog Is, Thumb Lake, beach

51 CICINDELA HIRTICOLLIS Say, 3, June 14 — July 27, High Is, Hog Is, beach The specimens referred here are intermediate between typical *hirticollis* and *rhodensis* All show some evidence of the humeral lunule, or of the lateral portion of the middle band, or both, on the disc of the elytron

51b CICINDELA HIRTICOLLIS RHODENSIS Calder, 6, June 14 — Aug 18, Beaver Is, High Is, beach The specimens assigned somewhat doubtfully to this Atlantic Coast variety vary from individuals having only the apical margins (remnant of apical lunule) and humerus of elytra marked, to individuals with the lateral margin marked, or with an indistinct sutural spot just behind the middle (a remnant of the median apex of the middle band), or both

53 CICINDELA TRANQUEBARICA Herbst, 8, May 26 — Sept 5, Beaver Is, Garden Is, High Is, beach and other exposed sandy areas

59 CICINDELA LONGILABRIS Say, 2, May 26 — Aug 26, Beaver Is, Garden Is, beach and other exposed sandy areas

74 CICINDELA PUNCTULATA Oliv, 2, July 28 — Aug 22, Hog Is, Charlevoix, beach

CARABIDAE

162 SPHAERODERUS LECONTEI Dej, 1, Aug 23, Beaver Is, under cover on damp ground

171 CARABUS SERRATUS Say, 4, July 7 — Sept 8, Beaver Is, High Is, Hog Is, under cover on damp ground about beach pool, in molasses trap

180 CALOSOMA SCRUTATOR Fab, 1, Aug 22, Charlevoix, fragment found in beach drift

183 CALOSOMA FRIGIDUM Kby, 1, July 10, Beaver Is

204 CALOSOMA CALIDUM Fab, 1, July 19, Boyne City, under stone on dry sandy ground

228 ELAPHRUS FULGINOSUS Say, 3, July 28 — Sept 1 (dead on latter date), Beaver Is, Garden Is, beach

233 ELAPHRUS RUSCARIUS Say, 3, June 23 — July 14, High Is, Gull Is

247 NOTIOPHILUS SEMISTRIATUS Say, 1, July 16, Thumb Lake, in grass

324 DYSCHIRIUS NIGRIPES Lec (det by Notman) 9, June 6 — Aug 31, Beaver Is, High Is, Gull Is, under cover on beach, on mud bank

330 DYSCHIRIUS LONGULUS Lec (det by Notman) 3, June 2 — Aug 27, Beaver Is, High Is, Hog Is, under cover on beach

359 CLIVINA IMPRESSIFRONS Lec, 4, July 8 — Aug 27, High Is, Gull Is, Charlevoix, beach One of the specimens departs from the typical for the species in that it is dark except the legs

416 BEMBIDION (ODONTIUM) CARINULA Chd, 14, June 2 — Aug 18, Garden Is, High Is, Hog Is, beach

438 BEMBIDION (EUDROMUS) NITIDUM (Kby), 4, June 2 — Sept 8, Beaver Is, High Is, under cover on sandy ground, under gravel on beach

540 BEMBIDION (PERYPHUS) TRANSVERSALE Dej, 12, June 2 — Aug 25, Beaver Is, Garden Is, High Is, Hog Is, Gull Is, under gravel and boards on damp beach

573 BEMBIDION (PERYPHUS) SCOPULINUM (Kby), 15, June 2 — Aug 29, Beaver Is, High Is, under gravel on beach

591 BEMBIDION (PERYPHUS) HONESTUM Say, 2, Aug 24, Hog Is, under gravel on damp beach

648 BEMBIDION (NOTAPHUS) POSTICUM (Hald) (det by Not-

man), 4, Sept 6 8, Beaver Is, under cover and on sand of damp beach

655 Bembidion (Notaphus) intermedium (Kby), 20, Aug 22–27, Beaver Is, Charlevoix, under cover on damp beach, on mud bank

660 Bembidion (Notaphus) variegatum Say, 5, Aug 22—Sept 1, Beaver Is, Charlevoix, on mud bank, under gravel and boards on beach

708 Bembidion (Notaphus) aestivum Csy (det by Notman), 1, Aug 31, Beaver Is, on mud bank

713 Bembidion (Notaphus) decipiens Dej (det by Notman), 1, Aug 31, Beaver Is, on mud bank

723 Bembidion (Notaphus) versicolor (Lec) (det by Notman), 3, Aug 27—Sept 1, Beaver Is, on mud bank, under gravel and boards on beach

805 Tachyura incurva (Say) (det by Notman), 5, Aug 30—Sept 1, Beaver Is, under cover on dry ground, under cover on beach

890 Tachyta nana (Gyll), 1, June 2, High Is, beach

901 Patrobus longicornis (Say), 10, June 14—Sept 7, Beaver Is, Garden Is, High Is, Hog Is, under cover on damp ground, under cover on beach

929 Myas coracinus (Say), 1, Aug 29, Beaver Is, under board on dry ground in open woods

1006 Pterostichus adoxus (Say), 2, July 21—Aug 22, High Is, Thumb Lake, molasses trap in hardwoods

1093 Euferonia coracina (Newm), 41, May 27—Sept 8, Beaver Is, Garden Is, High Is, Hog Is, under cover, especially on damp ground, but likewise in drier situations, on beach, etc, under bark

1162 Poecilus lucublandus Say, 18, May 27—Aug 30, Beaver Is, Garden Is, High Is, Charlevoix, under cover in dry situations, on beach

1174 Omaseus caudicalis (Say), 1, Sept 7, Beaver Is, under cover on beach

1175 Omaseus luctuosus (Dej), 1, Aug 24, Garden Is, under cover on damp ground

1176 Omaseus corvinus (Dej), 4, Aug 23–24, Beaver Is , Garden Is , under cover on beach and on damp ground

1178 Dysidius mutus (Say), 1, Aug 30, Beaver Is , under cover on dry ground

1181 Pseudargutor erythropus (Dej), 8, July 28 — Sept 7, Beaver Is , Garden Is , Hog Is , under cover on damp ground, on dry sand, on dry ground, on beach

1188 Bothriopterus pennsylvanicus (Lec), 1, June 6, High Is , under cover on beach

1194 Bothriopterus lucczoti (Dej) (det by Notman), 3, June 2 — Sept 25, Beaver Is , High Is , under cover on beach

1262 Leiocnemis avida (Say), 3, July 14 — Aug 31, Beaver Is , Gull Is , under cover on dry ground

1272 Bradytus latior Kby , 1, Aug 31, Beaver Is , under cover on dry ground

1281 Percosia obesa (Say), 7, July 10 — Sept 8, Beaver Is , Garden Is , Hog Is , under cover on sandy ground, beach drift, floating on surface of Lake Michigan one to two miles off shore

1309 Celia remotestriata Dej (det checked by Wallis), 19, Aug 23 — Sept 5, Beaver Is , under cover on beach, on sandy ground, and on dry ground

1350 Celia subaenea Lec (det by Wallis), 2, Aug 26–30, Beaver Is , under cover on dry ground and on sandy ground

1372 Celia musculus (Say) (det checked by Wallis), 34, Aug 24 — Sept 9, Beaver Is , Hog Is , under cover and gravel on damp beach and on dry sandy ground

1385 Amara impuncticollis Say, 1, June 1, Beaver Is , beach

1389 Amara fallax Lec (det by Wallis), 3, July 8 — Sept 2, Beaver Is , Boyne Falls, Boyne City, under cover on dry ground, swept from grass

1414 Amara convexa Lec (det by Wallis), 4, Aug 22 — Sept 7, Beaver Is , Charlevoix, under cover on beach and on dry sandy ground

1415 Amara polita Lec (?), 1, May 31, Gull Is , on sand in gull rookery

1444 Rembus obtusa Lec, 1, Sept 8, Beaver Is, under cover on damp beach

1471 Badister pulchellus Lec, 1, June 14, High Is, beach

1482 Calathus gregarius Dej, 2, June 2 — Aug 30, Beaver Is, High Is, under cover on dry ground

1489 Pristodactyla impunctata (Say) (det by Notman), 1, Sept 9, Beaver Is, under decaying fungus

1489a Pristodactyla convexa Csy (det by Notman), 1, Sept 6, Beaver Is, under decaying fungus

1513 Anchomenus decens Say, 5, Oct 5, High Is, under bark

1514 Anchomenus sinuatus Dej, 1, May 27, Garden Is, under log

1519 Anchomenus reflexus Lec, 5, July 7 — Aug 13, High Is, Hog Is, beach

1523 Anchomenus decorus Say, 2, July 8, Gull Is

1537a Agonum errans subcordatum Lec, 60, May 27 — Sept 6, Beaver Is, Garden Is, Hog Is, Whiskey Is, Boyne City, Thumb Lake, under cover on and near beach, swept from vegetation on beach

1541 Agonum mutatum G & H, 1, July 8, Boyne City, in pasture

1546 Agonum affine Kby, 1, June 2, High Is, beach

1553 Agonum cupripennis (Say), 18, June 7 — Sept 8, Beaver Is, High Is, Hog Is, under cover on sandy ground, on dry ground, on beach, and on damp sand about a beach pool

1567 Agonum placidum (Say), 4, July 16 — Aug 31, Beaver Is, High Is, Coyne Falls, under cover on dry ground and on dry sandy ground, at light

1570 Agonum cupreum Dej, 4, June 2 — Aug 27, Beaver Is, High Is, Charlevoix, under cover on beach

1573 Agonum bogemanni (Gyll), 1, June 7, High Is, beach

1574 Agonum quadripunctatum (Dej), 4, June 1–14, Beaver Is, High Is, beach

1579 Circinalia crenistriata Lec, 17, July 10 — Aug 31, Beaver Is, Charlevoix, under cover on beach, under cover on dry ground (15 specimens), beach drift

—— Europhilus lenis Dej , 6, July 8 — Aug 23, Beaver Is , Boyne Falls, Thumb Lake, under cover on beach, sweeping in marshy areas, in grass on ground, on ground and in molasses trap in hardwoods

1586 Agonum gemellum Lec , 1, Aug 24, Hog Is , under cover on damp ground

1612 Casnonia pennsylvanica L , 1, July 8, Gull Is

1620 Galerita bicolor Drury, 2, June 13 — Oct 5, High Is , beach, under bark

1642 Lebia atriventris Say, 2, June 6, High Is , under cover on beach

1655 Lebia viridis Say, 5, June 1 — Aug 29, Beaver Is , High Is , Gull Is , sweeping raspberry and rose bushes in clearing in woods, beach drift

1655 b Lebia viridis moesta Lec , 2, June 2 — Aug 24, High Is , Hog Is , sweeping, probably from Solidago flowers

1667 Lebia ornata Say, 1, July 31, Boyne Falls, sweeping in swamp

1672 Lebia fuscata Dej , 1, July 8, Gull Is

1675 Lebia scapularis Dej , 8, June 16, High Is , sweeping

1681 Lebia vittata Fab , 1, June 1, Beaver Is

1696 Blechrus glabratus (Duft), 11, June 2 — Sept 8, Beaver Is , High Is , Thumb Lake, Boyne City, under cover on beach, on dry sandy ground on dry ground, on ground in hardwoods, under bark'

1738 Cymindis cribricollis Dej , 1, Aug 29, under cover on dry ground in open woods

1746 Cymindis pilosa Say, 34, Aug 25 — Sept 9, Beaver Is , under cover on dry ground and on dry sandy ground The species of this genus are stated by Horn (*Trans Am Ent Soc* , 10 149) to be apterous, and this usually appears to be the case, but one specimen of this species in the author's collection from Cheyboygan County has fully developed and apparently functional wings This is, perhaps, significant, as suggesting the way in which this usually apterous group might make its way to the islands

1775 Brachinus janthinipennis (Dej) (det by Notman), 2,

Sept 8, Beaver Is, under cover on damp margin of beach pool

BRACHINUS REJECTUS Lec (det by Notman), 1, Sept 8, Beaver Is, under cover on damp margin of beach pool

1806 CHLAENIUS TOMENTOSUS Say, 2, Aug 18–26, Beaver Is, High Is, under cover on sandy ground, beach drift

1812 CHLAENIUS HARPALINUS Esch, 1, Aug 23, Beaver Is, under cover on beach

1814 CHLAENIUS IMPUNCTIFRONS Say, 1, July 23, Hog Is

1817 CHLAENIUS PENNSYLVANICUS Say, 14, June 6 — Sept 8, Beaver Is, High Is, under cover on damp beach, on sandy ground, and on dry ground

1819 CHLAENIUS BREVILABRIS Lec, 47, May 27 — Sept 7, Beaver Is, Garden Is, Hog Is, High Is, Boyne City, under cover on dry ground, under cover on beach

1821 CHLAENIUS TRICOLOR Dej, 6, June 23 — Sept 8, Beaver Is, Hog Is, under cover on beach

1822 CHLAENIUS NEMORALIS Say, 2, June 23 — Aug 27, Beaver Is, Hog Is, under cover on beach

1830 CHLAENIUS SOLITARIUS Say, 18, June 6 — Sept 20, Beaver Is, High Is, under gravel on damp beach

1846 CHLAENIUS SERICEUS Forst, 8, June 14 — Sept 8, Beaver Is, Garden Is, High Is, under cover on dry ground and on damp beach

1860 BRACHYLOBUS LITHOPHILUS (Say), 1, Aug 23, Beaver Is, under cover on beach

1882 NOTHOPUS VALENS Csy, 1, Aug 22, Charlevoix, beach

1896 HARPALUS CALIGINOSUS (Fab), extremely abundant, Aug 18 — Sept 8, Beaver Is, High Is, occurred mostly under cover in vicinity of recently harvested grain fields (Aug 31), where, before the grain had been cut, they had been seen in great numbers on the stalks apparently feeding on the kernels, beach drift, under cover on beach and on sandy ground

1897 HARPALUS ERRATICUS Say, extremely abundant, July 21 — Sept 9, Beaver Is, Garden Is, Thumb Lake, extremely abundant under cover on dry sandy ground, also under cover on beach, molasses trap in hardwoods, a single speci-

men found dead at the bottom of a pitcher-plant leaf (*Sarracenia purpurea* L) in sphagnum bog within fifty feet of a field where the beetles were abundant

1903 Harpalus viridiaeneus Beauv , 7, June 2 — Aug 31, Beaver Is , High Is , under cover on beach and on dry ground

1910 Harpalus erythropus Dej , 5, Aug 22 — Sept 8, Beaver Is , Charlevoix, under cover on beach and on dry ground

1915 Harpalus compar Lec , 35, Aug 22 — 29, Beaver Is , Hog Is , Charlevoix, under cover on beach, on damp ground, on sandy ground, and on dry ground in open woods

1922 Harpalus faunus Say (?), 1, Aug 30, Beaver Is , under cover on dry ground

1925 Harpalus pennsylvanicus DeG , 14, July 8 — Sept 7, Beaver Is , Gull Is , High Is , Charlevoix, Boyne City, under cover on dry sandy ground, on beach, and on dry ground in open woods

1933 Harpalus viduus Lec (?), 3, June 1 — Aug 22, Beaver Is , Hog Is , Charlevoix, under cover on beach

1934 Harpalus laticeps Lec (?), 1, June 1, Beaver Is , beach

1941 Harpalus cautus Dej (det by Notman), 1, Aug 31, Beaver Is , under cover on dry ground

1944 Harpalus pleuriticus Kby , 1, Sept 5, Beaver Is , under cover on dry sandy ground

1956 Harpalus herbivagus Say, 2, Aug 22 — Sept 1, under cover on beach

2070 Triplectrus carbonarius (Say), 1, Aug 30, Beaver Is , under cover on dry ground

2088 Anisodactylus nigerrimus Dej , 1, under gravel on beach

2090 Anisodactylus nigrita Dej , 5, Aug 24 — Sept 8, Beaver Is , Garden Is , under cover on damp beach, on damp ground, on dry ground

2091 Anisodactylus interpunctatus Kby , 1, June 14, High Is , beach

2112 Pseudamphasia sericea (Harris), 2, June 14 — July 7, High Is , beach

2126 ANADAPTUS DISCOIDEUS (Dej), 2, July 7, High Is

2127 ANADAPTUS BALTIMORENSIS (Say), 3, July 7 — Aug 31, Beaver Is , High Is , under cover on dry ground

2132 ANISOTARSUS SAYI Blatch , 1, Sept 5, Beaver Is , under cover on sandy ground

2138 ANISOTARSUS TESTACEUS (Hald), 15, Aug 26 — Sept 8, Beaver Is , under cover on sandy ground and on dry ground, one specimen on stalk of Erigeron apparently eating seeds

2139 ANISOTARSUS TERMINATUS (Say), 1, Aug 30, Beaver Is , under cover on dry ground

2158 TACHYCELLUS NIGRINUS (Dej), 1, July 14, Gull Is

2159 TRILIARTHRUS BADIIPENNIS (Hald), 1, June 2, High Is , beach

2218 STENOLOPHUS OCHROPEZUS (Say), 1, June 2, High Is , beach

2234 STENOLOPHUS PLEBEJUS Dej 2, Sept 1, Beaver Is , under gravel on beach

2235 STENOLOPHUS FUSCATUS Dej (det by Notman), 4, Sept 1 7, under gravel on beach

2238 STENOLOPHUS CONJUNCTUS Say (det by Notman), 10, May 16 — Sept 1, Beaver Is , Gull Is , under cover on sandy ground, on dry ground, and on gravel beach

2247 TACHISTODES PAUPERCULUS Dej (det by Notman), 4, July 8 – Sept 7, Beaver Is , Gull Is , Boyne City, herbage along beach

2251 AGONODERUS LINEOLA (Fab), 2, June 14 — Aug 24, High Is , beach

2261 AGONODERUS COMMA (Fab), 10, June 2 — Sept 8, Beaver Is , High Is , under cover on beach, on dry ground, on mud bank, and about beach pool

OMOPHRONIDAE

2284 OMOPHRON AMERICANUM Dej , 1, July 7, High Is

HALIPLIDAE

2301 HALIPLUS TRIOPSIS Say, 1, Aug 26, Beaver Is , aquatic Chara, Faunt Lake

2305 Haliplus cribrarius Lec, 1, Sept 1, Beaver Is, aquatic shallow beach pond

2318 Haliplus immaculicollis Harr, 16, July 17 — Sept 7, Beaver Is, Thumb Lake, aquatic beach ponds, submerged vegetation in lake in bog, ditch in bog

2324 Peltodytes tortulosus Rbts, 3, July 17, Thumb Lake, aquatic vegetation choked pond

DYTISCIDAE

2351 Laccophilus maculosus (Germ), 91, July 17 — Sept 7, Beaver Is, High Is, Thumb Lake, aquatic 76 specimens from beach ponds, streamlets running down beach from adjacent cedar bog, muck margin of Round Lake, submerged vegetation of lake in bog

2374 Desmopachria convexa (Aube), 1, Sept 6, Beaver Is, aquatic marshy area in Faunt Lake

2390 Bidessus affinis (Say), 23, July 8 — Sept 8, Beaver Is, Boyne City, Thumb Lake, aquatic streamlets running down beach from adjacent cedar bog, beach ponds, ponds by road through cedar bog, aquatic vegetation by margin of lakes and ponds, bog lake

2395 Bidessus fuscatus (Cr), 1, Aug 13, Hog Is, pool on beach

2403 Coelambus punctatus, (Say), 47, June 23 — Sept 25, Beaver Is, High Is, Thumb Lake, aquatic beach ponds, ditch in bog

2408 Coelambus turbidus (Lec), 43, Sept 1–7, Beaver Is, aquatic beach ponds

2414 Coelambus sellatus (Lec), 7, Sept 1–7, Beaver Is, aquatic beach ponds

2424 Coelambus impresso-punctatus (Sch), 5, June 1 — Sept 7, Beaver Is, aquatic muck margin of Round Lake, marshy area along Faunt Lake, beach ponds

2425 Coelambus laccophilinus (Lec), 1, Sept 6, Beaver Is, aquatic marshy area in Faunt Lake

2426 Coelambus sylvanus Fall, 9, Aug 25 — Sept 8; Beaver

Is , aquatic beach ponds, pools by road through cedar bog, muck shore of Round Lake

2428 DERONECTES DEPRESSUS (Fab) (det by Wallis), 6, Aug 23–25 Beaver Is , aquatic small streamlets running down beach from adjacent cedar bog, beach ponds

2447 HYDROPORUS UNDULATUS Say (det by Wallis), 5, June 23 — Sept 7, Beaver Is , High Is , aquatic submerged vegetation in Faunt Lake, beach ponds

2454 HYDROPORUS CONSIMILIS Lec (det by Wallis), 130 Aug 26 — Sept 6, Beaver Is , aquatic submerged vegetation in Faunt Lake

2493 HYDROPORUS TENEBROSUS Lec (det by Wallis), 1, Aug 30, Beaver Is , aquatic pools by road through cedar bog

2501 HYDROPORUS TRISTIS (Payk) (? det by Wallis), 1, Aug 31, Beaver Is , aquatic muck shore of Round Lake

2508 HYDROPORUS SIGNATUS Mann (det by Wallis), 5, Aug 31, Beaver Is , aquatic muck margin of Round Lake

2514 HYDROPORUS NIGER Say (det by Wallis), 2, Sept 6, Beaver Is , aquatic marshy area in Faunt Lake

—— HYDROPORUS DENTELLUS Fall (det by Wallis), 2, Aug 30, Beaver Is , aquatic pools by road through cedar bog

—— HYDROPORUS STRIOLA Gyll (det by Wallis), 1, Sept 6, Beaver Is , aquatic marshy area in Faunt Lake

AGABUS SUBFUSCATUS Shp (? det by Wallis), 2, Aug 30, Beaver Is , aquatic pools by road through cedar bog

2575 AGABUS ANTHRACINUS Mann (det by Wallis), 1, Aug 30, Beaver Is , aquatic pools by road through cedar bog

2594 ILYBIUS IGNARUS Lec (det by Wallis), 1, Aug 30, Beaver Is , aquatic pools by road through cedar bog

2598 ILYBIUS BIGUTTULUS (Germ) (? det by Wallis), 3, Aug 22–30, Beaver Is , Charlevoix, aquatic pools by road through cedar bog, under board in mud by beach pool

2610 COPTOTOMUS INTERROGATUS (Fab), 1, Sept 6, Beaver Is , aquatic marshy area in Faunt Lake

2616 RHANTUS BINOTATUS (Harr), 9, Aug 18 — Sept 1, Beaver Is , High Is , aquatic beach pool, marshy area by Faunt Lake, pools by road through cedar bog, beach drift

2623 RHANTUS BISTRIATUS (Bergst), 1, July 10, Beaver Is , beach drift

2636 DYTISCUS FASCIVENTRIS Say, 4, July 7 — Oct 3, Beaver Is , High Is , Hog Is

2647 HYDATICUS STAGNALIS (Fab), 2, July 10 — Aug 13, Beaver Is , Hog Is , beach drift One of the specimens is without the light stripes on the elytra

2651 ACILIUS SEMISULCATUS Aube, 23, July 17 — Sept 9, Beaver Is , High Is , Charlevoix, Thumb Lake, floating on surface of Lake Michigan one to two miles off Hog Is , aquatic beach ponds, pools by road through cedar bog, aquatic vegetation of lakes and ponds, beach drift

GYRINIDAE

2679 DINEUTES NIGRIOR Rbts , 9, June 21 — Sept 25, Beaver Is , High Is , surface of beach pools and small lakes

2680 DINEUTES AMERICANUS Say, 4, Aug 22 31, Beaver Is , Charlevoix, surface of beach pools

2681 DINEUTES HORNII Rbts , 2, June 1 — Sept 6, Beaver Is , surface of Faunt Lake in marshy area

2684 GYRINUS MINUTUS Fab , 3, June 28, High Is , surface of small lakes

—— GYRINUS LECONTEI Fall (det by Wallis), 106, Aug 22 — Sept 8, Beaver Is , Charlevoix, surface of beach ponds, pools by road through cedar bog, ditch

HYDROPHILIDAE

2739 HELOPHORUS TUBERCULATUS Gyll , 1, Aug 13, Hog Is , aquatic

2750 HELOPHORUS LINEATUS Say, 2, June 15 — July 8, Gull Is , aquatic

2764 HYDROCHUS SQUAMIFER Lec , 5, Aug 25 — Sept 8, Beaver Is , aquatic beach ponds, pools by road through cedar bog

2777 BEROSUS PEREGRINUS (Hbst), 8, Aug 24 — Sept 7, Beaver Is , Garden Is , aquatic submerged vegetation near

shore of Faunt Lake, beach ponds, under cover on damp beach

2784 Berosus striatus (Say), 30, Aug 25 - Sept 7, Beaver Is, aquatic at margins of beach ponds, muck margin of Round Lake, submerged vegetation in Faunt Lake

2795 Hydrophilus obtusatus Say, 2, Aug 18 — Sept 2, Beaver Is, High Is, aquatic beach ponds, beach drift

2805 Tropisternus glaber (Hbst), 2, June 14 — July 30, High Is, Thumb Lake, ditch in bog

2806 Tropisternus mixtus (Lec), 4, Aug 10–30, Beaver Is, Hog Is, aquatic pools by road through cedar bog, beach drift

2807 Tropisternus lateralis (Fab), 33, June 16 - Sept 7, Beaver Is, High Is, Charlevoix, aquatic beach ponds, muck margins and in vegetation of small lakes, beach drift, at sugar on tree in evening

2808 Hydrobius fuscipes L, 8, July 7 — Sept 8, Beaver Is, High Is, Hog Is, aquatic beach ponds, pools by road through cedar bog, beach drift

2810 Hydrobius globosus (Say), 1, Sept 1, Beaver Is, aquatic beach pond

2818 Paracymus despectus (Lec) (?), 1, Aug 24, Garden Is, under stone on wet beach

2819 Paracymus subcupreus (Say), 13, Aug 30 — Sept 8, Beaver Is, aquatic pools by road through cedar bog, beach ponds

2834 Enochrus nebulosus (Say), 5, July 8 — Sept 6, Beaver Is, Gull Is, Boyne City, aquatic beach ponds, marshy area in Faunt Lake

2835 Enochrus ochraceus (Melsh), 1, Sept 6, Beaver Is, aquatic marshy area in Faunt Lake

2851 Cymbiodyta blanchardi Horn, 11, June 16 — Sept 7, Beaver Is, High Is, aquatic beach ponds, pools by road through cedar bog, muck margin of Round Lake

2853 Helocombus bifidus (Lec), 1, Sept 6, Beaver Is, aquatic marshy area in Faunt Lake

2854 Laccobius agilis Rand, 53, July 28 — Sept 7, Beaver

Is , Garden Is , found buried in sand at water-level of beach ponds and small streamlets running down beach from adjacent cedar bog

2867 SPHAERIDIUM SCARABAEOIDES (L), 4, July 8 — Sept 2, Beaver Is , High Is , Boyne City, cattle dung

2885 CERCYON PYGMAEUS (Illig) (?), 9, Sept 2 9, Beaver Is , cattle dung

2899 CRYPTOPLEURUM MINUTUM (Fab), 1, Sept 2, Beaver Is , cattle dung

SILPHIDAE

2912 NECROPHORUS SAYI Lap , 2, July 19, Thumb Lake, carrion

2913 NECROPHORUS ORBICOLLIS Say, 21, July 19 — Sept 9, Beaver Is , Thumb Lake, carrion

2918 NECROPHORUS PUSTULATUS Hersch , 2, July 19 — Sept 4, Beaver Is , Thumb Lake, carrion

2919 NECROPHORUS VESPILLOIDES Hbst 11, July 19, Thumb Lake, carrion

2920 NECROPHROUS TOMENTOSUS Web , 25, July 19 — Sept 4, Beaver Is , Thumb Lake, carrion

2922 SILPHA (NECRODES) SURINAMENSIS Fab , 25, July 21 — Sept 4, Beaver Is , Thumb Lake, carrion

2923 SILPHA (THANATOPHILUS) LAPPONICA Hbst , 5, July 27 — Sept 2, Beaver Is , High Is , carrion

2927 SILPHA NOVEBORACENSIS Forst , 8, July 21 — Sept 2, Beaver Is , Garden Is , Thumb Lake, carrion

2928 SILPHA AMERICANA L , 1, July 21, Thumb Lake, carrion

2951 CHOLEVA BASILLARIS Say (det by Dietrich), 8, July 19 — Sept 10, Beaver Is , Thumb Lake, carrion

2952 CHOLEVA CLAVICORNIS (Lec), 10, July 21 — Aug 31, Beaver Is , Thumb Lake, carrion

2957 PRIONOCHAETA OPACA (Say), 1, July 19, Thumb Lake, carrion

3003 ANISOTOMA COLLARIS Lec (det by Dietrich), 1, Sept 6, Beaver Is , damp sand on beach

SCYDMAENIDAE

3216 Eumicrus motschulskii (Lec), 1, Sept 1, Beaver Is , under cover on gravel beach

STAPHYLINIDAE

3424 Acidota crenata (Fab) (?), 3, June 2–14, High Is , beach

3461 Geodromicus brunneus (Say), 7 June 1 — Aug 27, Beaver Is , High Is , under cover on beach

3508 Trogophloeus phloeoporinus Lec (det by Notman), 1, Sept 5, Beaver Is , fungus

3596 Platystethus americanus Erichs (det by Notman), 1, Aug 22, Charlevoix, cattle dung

—— Stenus anastomozans Csy (det by Blaisdell), 1, Aug 31, Beaver Is , muck bank

3787 Stenus stygicus Say (det by Blaisdell), 19, Aug 23 — Sept 7, Beaver Is , Garden Is , under cover on damp or wet beach, on muck bank

—— Stenus milleporus Csy (det by Blaisdell), 1, Aug 23, Beaver Is , under cover on damp beach

3908 Gastrolobium bicolor (Grav), 13, June 3 — Sept 7, Beaver Is , Garden Is , Hog Is , under cover on damp beach

3926 Hesperobium pallipes (Grav), 2, July 16–28, Garden Is , Hog Is , under cover on beach

3932 Hesperobium sellatum (Lec), 2, Sept 8, Beaver Is , under cover on damp beach

3952 Paederus (Paederillus) littorarius Grav , 4, May 16 — Sept 25, under cover on dry ground

4016 Tetartopeus punctulatus (Lec), 2, Aug 29–31, Beaver Is , under cover on gravel beach, under cover on dry ground

4105 Trachysectus confluentus (Say), 4, May 16 — Sept 10, Beaver Is , Garden Is , High Is , in rotten wood

4272 Astenus discopunctatus (Say), 1, Aug 30, Beaver Is , under cover on dry ground

4285 NUDOBIUS CEPHALUS (Say), 4, June 2 — Sept 8, Beaver Is, High Is, under bark of decaying balsam trunk, beach

4308 GYROHYPNUS HAMATUS (Say), 8, June 2 15, High Is, Gull Is, under cover on beach

4319 GYROHYPNUS GULARIS (Lec), 1, Aug 31, Beaver Is, under cover on dry ground

4384 PHILONTHUS POLITUS (L), 6, July 21 — Sept 4, Beaver Is, Thumb Lake, carrion

—— PHILONTHUS TETRAGONOCEPHALUS Notman, 1, Aug 13, Hog Is

4418 PHILONTHUS QUADRICOLLIS Horn (?), 16, May 29 — Sept 9, Beaver Is, High Is, Garden Is, Gull Is, Whiskey Is, Boyne City, Thumb Lake, carrion, cattle dung, vegetation on beach

—— PHILONTHUS CRUENTATUS Gmel, 10, July 8 — Sept 2, Beaver Is, High Is, Garden Is, Charlevoix, Boyne City, carrion, cattle dung, under cover on beach, vegetation on beach

4431 PHILONTHUS FULVIPES (Fab), 2, Aug 30–31, Beaver Is, under cover on dry ground

4473 PHILONTHUS MICROPHTHALMUS Horn (?), 1, Aug 31, Beaver Is, cattle dung

4474 PHILONTHUS CEPHALICUS Csy (det by Notman), 1, Aug 31, Beaver Is, carrion

4489 PHILONTHUS CONFERTUS Lec, 2, June 1–16, Beaver Is, High Is, beach

4546 STAPHYLINUS VIOLACEUS Grav, 4, June 5 — Sept 10, Beaver Is, High Is, Thumb Lake, under bark of rotten log, carrion

4552 ONTHOLESTES CINGULATUS (Grav), 7, July 21 — Sept 25, Beaver Is, High Is, Thumb Lake, carrion, dung

4555b CREOPHILUS MAXILLOSUS VILLOSUS (Grav), 17, July 7 — Sept 4, Beaver Is, High Is, Garden Is, Thumb Lake, carrion

4575 QUEDIUS LAEVIGATUS (Gyll), 5, June 2 — Aug 24, High Is, under bark

4634 OXYPORUS VITTATUS Grav, 1, Sept 20, Beaver Is.

4635 Oxyporus fasciatus Horn, 1, Sept 5, Beaver Is, fungus

4652 Tachinus memnonius Grav, 10, Sept 5–10, Beaver Is, fungi

4682a Tachyporus chrysomelinus acaudus Say, 2, Aug 30—Sept 9, Beaver Is, under cover on dry ground, sifting damp ground debris in pine woods

4690 Erchomus ventriculus (Say), 7, Sept 9–10, Beaver Is, in rotten wood

4698 Conosoma imbricatus Csy, 1, Sept 6, Beaver Is, in rotten wood

4725 Bolitobius pygmaeus (Fab) (?), 5, Sept 5–9, Beaver Is, fungi

4727 Bolitobius trinotatus Er, 1, Sept 1, Beaver Is, fungus

4738 Mycetoporus humidus Say, 1, Aug 26, Beaver Is, under cover on dry sandy ground

4770 Myllaena vulpina Bnhr (det by Fenyes), 1, Aug 29, Beaver Is, sweeping herbage

4928 Silusida marginella Csy (det by Fenyes), 2, Sept 5, Beaver Is, fungus

4961 Gyrophaena flavicornis Melsh (det by Fenyes), 6, Sept 5, Beaver Is, fungi

4984–4985 Gyrophaena nana Payk (det by Fenyes), 9, Sept 5–9, Beaver Is, fungi Casey's *perpolita* and *tenebrosa* are synonyms (Fenyes)

5099 Atheta divisa Mark (det by Fenyes), 2, Aug 31, Beaver Is, carrion

5112 Atheta virginica Bnhr (det by Fenyes), 3, Aug 30—Sept 5, Beaver Is, carrion, fungi

5271 Atheta (Homalotusa) lacustrina Csy (? det by Fenyes), 1, Sept 10, Beaver Is, under bark of rotten log

5540 Dimetrota maeklini Fenyes (det by Fenyes), 1, Sept 5, Beaver Is, fungus A new name for *D moesta* Makl (Fenyes)

5598–5603 Arisota recondita Er (det by Fenyes), 14, Aug 27—Sept 9, Beaver Is, cattle dung Dr Fenyes writes

"Casey's *Aristota* is a valid genus, but his *tetricula*, *insueta*, *pomonensis*, *speculifer*, *apacheella*, and *umbrina* are all synonyms of the old Erichsonian *recondita*"

5627 ATHETA (ACROTONA) FUNGI (Grav) (det by Fenyes), 2, Sept 7–9, Beaver Is , sifting debris on ground in pine woods

5678 ATHETA (COPROTHASSA) SORDIDA (Marsh) (det by Fenyes), 25, Aug 31 — Sept 2, Beaver Is , cattle dung

5702 GNYPETA NIGRELLA (Lec) (det by Fenyes), 1, Sept 7, Beaver Is , margin of beach pool

5755 FALAGRIA DISSECTA Er (det by Fenyes), 9, Aug 31 — Sept 2, Beaver Is , cattle dung

5766 ALEOCHARA LATA Grav , 16, July 21 — Sept 4, Beaver Is , Thumb Lake, carrion

5785 EXALEOCHARA MORION Grav (det by Fenyes), 1, Aug 31, Beaver Is , cattle dung

5799 ALEOCHARA (ISOCHARA) SCULPTIVENTRIS Csy (det by Fenyes), 1, Sept 2, Beaver Is , carrion

5806 ALEOCHARA (COPROCHARA) BIMACULATA Grav (det by Fenyes), 16, Aug 24 — Sept 2, Beaver Is , Garden Is , cattle dung, in vicinity of carrion

5820 ALEOCHARA (COPROCHARA) BIPUSTULATA L (det by Fenyes), 4, Sept 2–9, Beaver Is , cattle dung, beaten from white pine

5898 OXYPODA (BESSOPORA) NIGRICEPS Csy (det by Fenyes), 2, Sept 9, Beaver Is , sifting debris on ground in pine woods

6018 PHLOEOPORA TESTACEA (Mann) (det by Fenyes), 2, Sept 8, Beaver Is , under bark of decaying balsam trunk

PSELAPHIDAE

6201 BATRISODES SPRETUS (Lec) (?), 1, July 18, Thumb Lake, among dead leaves on ground in hardwoods

SCAPHIDIIDAE

6489 SCAPHIOSOMA CONVEXUM Say, 1, July 19, Thumb Lake, carrion

6506 Scaphiosoma terminatum Melsh, 1, Sept 9, Beaver Is, carrion

6516 Baeocera congener Csy, 1, Aug 21 Beaver Is, sweeping herbage

HISTERIDAE

6571 Hister interruptus Beauv, 2, June 1 -- Aug 9, Beaver Is, High Is beach

6591 Hister marginicollis Lec, 4, June 21 — Sept 4, Beaver Is, High Is, cattle dung, carrion

6596 Hister abbreviatus Fab, 4, Aug 24 — Sept 2, Beaver Is, Garden Is, cattle dung, carrion

6601 Hister furtivus Lec (det checked by Blaisdell), 10, Sept 2–4, Beaver Is, cattle dung, carrion

6606 Hister depurator Say, 14, July 21 — Sept 9, Beaver Is, Thumb Lake, carrion, cattle dung

6627 Hister (Athous) americanus Payk, 1, July 8, Gull Is

6627a Hister (Athous) americanus perplexus Lec, 2, June 14 — July 8, Gull Is, High Is, beach

6653 Platysoma depressum Lec, 13, May 15 — Aug 9, Garden Is, High Is, under bark

6756 Plegaderus sayi Mars, 1, June 2, High Is, beach

6827 Saprinus lugens Er, 1, Aug 31, Beaver Is, carrion

6831a Saprinus oregonensis distinguendus Mars, 2, July 21 — Sept 4, Beaver Is, Thumb Lake, carrion

6836 Saprinus assimilis Payk, 1, Sept 4, Beaver Is, carrion

6875 Saprinus (Hypocaccus) sphaeroides Lec, 1, May 16, Beaver Is

6885 Saprinus (Hypocaccus) fraternus Say, 18, May 16 — Aug 27, Beaver Is, Garden Is, Gull Is, Hog Is, High Is, beach

6896 Saprinus (Hypocaccus) patruelis Lec, 1, July 28, Hog Is

LYCIDAE

6926. Calopteron reticulatum (Fab), 1, July 8, Boyne Falls, swept from grass in swampy area

6931 CELETES BASALIS Lec , 5, July 16 — Aug 2, High Is , at light

6946 PLATEROS CANALICULATUS (Say) (?), 4, June 27 — July 14, High Is , Thumb Lake, at light

LAMPYRIDAE

6971 LUCIDOTA (RILEYA) ATRA (Fab), 1, July 18, Thumb Lake, herbage

6975 LUCIDOTA (ELLYCHNIA) CORRUSCA (L), 6, May 27 — Sept 8, Beaver Is , Hog Is , sweeping herbage in fields and hardwoods

6977 LUCIDOTA (PYROPYGA) FENESTRALIS (Melsh), 14, July 8 — Aug 3, Garden Is , Gull Is , Boyne City, Thumb Lake, herbage, often in marshy areas

6978 LUCIDOTA (PYROPYGA) NIGRICANS (Say) (?), 1, July 17, Thumb Lake, beaten from tamarack in bog

6984 PYRACTOMENA ANGULATA (Say), 1, June 14, High Is

6990 PHOTINUS ARDENS Lec , 2, July 8, Gull Is

7013 PHOTURIS PENNSYLVANICA (DeG), 2, July 8–16, Garden Is , High Is , beating, at light

CANTHARIDAE

7061 PODABRUS DIADEMA (Fab) (?), 2, June 14 — July 12, High Is

7062 PODABRUS MODESTUS (Say), 1, June 27, High Is

7092 CANTHARIS EXCAVATUS Lec , 1, June 8, Hog Is , beating

7100 CANTHARIS NIGRITULUS Lec (?), 5, June 27 — July 19, High Is , Gull Is , Boyne City, Thumb Lake, vegetation on beach, molasses trap in hardwoods

7106 CANTHARIS SCITULUS Say (?), 1, July 8, Boyne City, vegetation on beach

7107 CANTHARIS PUSILLUS Lec (?), 2, July 18–19, Thumb Lake, molasses trap and on ground in hardwoods

7113 CANTHARIS ROTUNDICOLLIS Say, 2, June 23, High Is , hardwoods.

7152 SILIS PERCOMIS (Say), 6, June 5–14, Beaver Is , High Is , Hog Is , beating

MELYRIDAE

7215 COLLOPS VITTATUS (Say), 1, July 19, Thumb Lake, under cover on beach

7227 COLLOPS QUADRIMACULATUS (Fab), 2, July 8 18, Boyne City, Thumb Lake, herbage

CLERIDAE

7629 TRICHODES NUTALLI Kby , 5, July 8–12, Thumb Lake, Boyne City, vegetation on beach, milkweed

7677 HYDNOCERA PALLIPENNIS Say, 2, Sept 6, Beaver Is , herbage

7694 ZENODOSUS SANGUINEUS (Say), 1, June 21, High Is

CORYNETIDAE

7729 NECROBIA VIOLACEA (L), 4, June 1, Beaver Is , carrion

CEPHALOIDAE

7747 CEPHALOON LEPTURIDES Newm , 2, June 23, High Is

MORDELLIDAE

7817 MORDELLA MARGINATA Melsh (det by Liljeblad), 1, Sept 6, Beaver Is , flowers of Gnaphalium

7845 MORDELLISTENA BIPLAGIATA Hellm , 4, June 23 — July 14, High Is , Gull Is , flowers in hardwoods

7860 MORDELLISTENA ASPERSA (Melsh) (det by Liljeblad), 2, Aug 29, Beaver Is , sweeping Solidago flowers

7888 MORDELLISTENA PUSTULATA (Melsh) (det by Liljeblad), 1, Aug 29, Beaver Is , sweeping Solidago flowers

7915 MORDELLISTENA PITYPTERA Lec (det by Liljeblad), 1, Sept 6, Beaver Is , sweeping herbage

7942 ANASPIS FLAVIPENNIS Hald , 8, June 2–22, High Is
7943 ANASPIS RUFA Say, 12, June 14–22, High Is , Gull Is

MELOIDAE

8042 MACROBASIS UNICOLOR (Kby), 8, June 15 — July 20, High Is , Gull Is , on small shrubs on beach
8147 MELOE ANGUSTICOLLIS Say, 7, June 22 — July 26, High Is , on path through low grassy marsh

PYROCHROIDAE

8220 NEOPYROCHROA FLABELLATA Fab , 1, July 21, Thumb Lake, under gravel on beach
8225 DENDROIDES BICOLOR Newm , 9, June 7 — July 30, High Is , at light, on rotten log, bred from pupae taken under bark of rotten log (July 12)
8226 DENDROIDES CONCOLOR Newm , 4, June 23 — July 16, High Is , at light, on rotten log

PEDILIDAE

8264 STEREOPALPUS MELLYI Laf , 2, July 7–8, High Is,, Boyne City, on *Populus candicans* and tamarack along shore
8265 STEREOPALPUS VESTITUS (Say), 2, July 7–11, Beaver Is , on *Populus candicans*

ANTHICIDAE

8302 NOTOXUS ANCHORA Horn, 6, July 7–19, High Is , Boyne City, Thumb Lake, vegetation in swampy area, on beach
8342 AMBLYDERUS PALLENS (Lec), 2, Aug 22–27, Beaver Is , Charlevoix, beach
8397 ANTHICUS EPHIPPIUM Laf , 1, Sept 1, Beaver Is , under cover on gravel beach
8417 ANTHICUS CERVINUS Laf , 9, July 7 — Aug 30, Beaver Is , High Is , Gull Is , Thumb Lake, under cover and on beach, under cover on dry ground

8448 ANTHICUS MELANCHOLICUS Laf, 1, Sept 7, Beaver Is, beaten from Iris

ELATERIDAE

8557 ADELOCERA BREVICORNIS Lec, 3, June 14 — Nov 5, High Is, under bark of stump of *Pinus resinosa*, beach

8627 LIMONIUS CONFUSUS Lec, 1, June 23, High Is, hardwoods

8658 LEPTOSCHEMA DISCALCEATUM (Say), 1, Aug 24, High Is

8663 ATHOUS ACANTHUS (Say) (det by Quirsfeld), 11, July 8–19, Boyne City, Thumb Lake, herbage, undergrowth and molasses trap in hardwoods

8667 ATHOUS CUCULLATUS (Say), 2, July 12–16, High Is, Thumb Lake, undergrowth in hardwoods

8698 LEPTUROIDES PRODUCTUS (Rand), 1, June 20, High Is

8699 LEPTUROIDES DENTICORNIS (Kby), 1, June 23, High Is, flowers of *Acer spicatum*

8705 LUDIUS VIRENS (Schrank) (det by Quirsfeld), 1, June 1, Beaver Is

8707 LUDIUS RESPLENDENS (Esch) (det by Quirsfeld), 1, June 23, High Is, hardwoods

8739 LUDIUS SPINOSUS (Lec), 1, June 8, Hog Is, beating

8748 LUDIUS SULCICOLLIS (Say), 4, July 20 — Sept 27, High Is, at sugar in evening

8763 LUDIUS PROPOLA (Lec) (det by Quirsfeld), 1, May 15, Garden Is

8766 LUDIUS TRIUNDULATUS (Rand), 1, June 16, High Is, sweeping

8769 LUDIUS MEDIANUS (Germ), 4, May 27 — June 3, Garden Is, Hog Is, beating, on beach

8796 LUDIUS HIEROGLYPHICUS (Say), 2, July 7–15, High Is, Hog Is

8821 CRYPTOHYPNUS EXIGUUS Rand, 6, June 2 — July 16, High Is, Garden Is, Boyne City, beach

8828 CRYPTOHYPNUS NOCTURNUS (Esch) (det by Quirsfeld), 1, June 2, High Is, beach

8848 HYPNOIDUS OBLIQUATULUS (Melsh), 1, May 29, Trout Is , beach

8878 DOLOPIUS LATERALIS Esch (det by Quirsfeld), 7, May 29 — July 8, Hog Is , Trout Is , Boyne City, vegetation on beach

8886 AGRIOTES STABILIS (Lec) (det by Quirsfeld), 6, May 16 — July 14, Beaver Is , Garden Is , High Is , Gull Is , beach

8888 AGRIOTES FUCOSUS (Lec), 3, June 8 — July 26, High Is , Hog Is , beating

8932 ELATER PULLUS Germ , 3, June 8, Hog Is

8941 ELATER SEMICINCTUS Rand , 1, June 23, High Is , hardwoods

—— ELATER LONGIPENNIS Notman (? det by Quirsfeld), 1, June 5, High Is

8953 ELATER APICATUS Say, 1, June 20, High Is

8966 ELATER SOCER Lec , 4, May 31 — July 7, High Is , Gull Is , beach

9015 MELANOTUS CASTANIPES (Payk), 8, June 8-16, High Is , under cover on beach, sweeping, under bark of *Pinus resinosa*

9036 MELANOTUS FISSILIS Say (det by Quirsfeld), 4 June 8— Aug 22, Beaver Is , High Is , Hog Is , Charlevoix, beach, beating, under cover on dry sandy ground

9071 CARDIOPHORUS CARDISCE (Say), 2, May 31 — June 15, Gull Is , gravel beach

9087 CARDIOPHORUS GAGATES Er , 3, June 8, Hog Is , beating

MELASIDAE

9133 DELTOMETOPUS AMOENICORNIS (Say), 1, July 20, High Is

9147 FORNAX CALCEATUS (Say), 1, July 16, Thumb Lake, on undergrowth in hardwoods

THROSCIDAE

9182a DRAPETES GEMINATUS NITIDUS Melsh , 1, July 19, Thumb Lake, under cover on beach

BUPRESTIDAE

9333 Dicerca divaricata (Say), 3, July 18—Sept 9, High Is, Gull Is, Thumb Lake, beach drift
9335 Dicerca prolongata Say (det by Andrews), 3, June 3—July 19, High Is, Hog Is, on cut pulp wood on beach
9351 Poecilonata cyanipes (Say), 4, July 5—Sept 14, Garden Is High Is, on cut pulp wood on beach
9370 Buprestis maculativentris Say, 5, July 12—Aug 1, High Is, Boyne Falls, Norwood Township, flying, vegetation on beach
9387 Melanophila fulvoguttata (Harris), 3, July 19, High Is, on cult pulp wood on beach
9391 Melanophila acuminata (DeG), 6, June 16—Aug 22, High Is, Hog Is, beach drift, hardwoods
9466 Chrysobothris femorata (Oliv), 4, June 23—July 19, High Is, on cut pulp wood on beach, hardwoods
9515 Agrilus masculinus Horn, 4, July 7, High Is
9542 Agrilus politus (Say), 3, July 8—Aug 24, High Is, Garden Is, herbage
9572 Brachys aerosus Melsh, 3, June 5—July 26, High Is, Thumb Lake, sweeping in swampy area

HETEROCERIDAE

9650 Heterocerus collaris Kies, 1, Aug 24, Garden Is, under cover on damp beach
9651 Heterocerus tristis Mann, 1, June 22, High Is

HELODIDAE

9698 Cyphon variabilis (Thunb), 5, July 8—Aug 24, High Is, Gull Is, Charlevoix, Thumb Lake, herbage, beaten from tamarack in bog
9709 Scirtes orbiculatus (Fab), 3, July 18–19, Thumb Lake, herbage
9716 Ptilodactyla serricollis (Say), 7, July 8, Boyne City, vegetation on beach

DERMESTIDAE

9725 Dermestes caninus Germ , 19, Sept 3–4, Beaver Is , carrion, especially more or less dried

9732 Dermestes vulpinus Fab , 1, May 31, Gull Is , on sand in gull rookery

BYRRHIDAE

9864 Cytilus alternatus (Say), 7, May 16 — Sept 8, Beaver Is , Hog Is , High Is , beach drift, under cover on dry sandy ground, under cover on beach

9889 Byrrhus kirbyi Lec (?), 31, May 27 — Sept 5, Beaver Is , Hog Is , High Is , beating, beach drift, 26 specimens under single railroad tie on dry sandy ground, Aug 26 and Sept 5

9893 Porcinolus undatus (Melsh), 1, Sept 8, Beaver Is , under cover on dry sandy ground

9905 Limnichites punctatus (Lec) (det by Dietrich), 1, Sept 9, Beaver Is , sifting ground debris in pine forest

OSTOMIDAE

9977 Tenebroides mauritanicus (L), 1, Sept 6, Beaver Is , in hotel

9994 Tenebroides corticalis (Melsh), 6, June 2 — Sept 6, Beaver Is , High Is , under bark of dead limb of *Populus grandidentata*

NITIDULIDAE

10052 Carpophilus niger (Say), 1, June 27, High Is

10057 Carpophilus corticinus Er (det by Dietrich), 7, June 2–5, High Is , beach

10065 Nitidula bipunctata (L), 1, June 1, Beaver Is , carrion

10067 Nitidula rufipes (L), 2, June 1, Beaver Is , carrion

10069 Omosita colon (L), 1, June 1, Beaver Is ; carrion

10083 Epuraea avara (Rand) (?), 2, June 2–5, High Is.

10099 Stelidota octomaculata Say (det by Dietrich), 10, Aug 28—Sept 9, fungi

CUCUJIDAE

10199 Silvanus planatus Germ, 4, June 21, High Is
10200 Silvanus imbellis Lec, 1, Aug 9, High Is
10221 Cucujus clavipes Fab, 2, June 2, High Is, under bark

EROTYLIDAE

10292a Aeropteroxys gracilis inornata Rand, 3, July 8–19, Boyne Falls, Thumb Lake, herbage
10334 Triplax thoracica Say, 8, June 1, Beaver Is, fungi

BYTURIDAE

9718 Byturus unicolor Say, 2, July 8, Boyne City, herbage, probably Rubus

MYCETOPHAGIDAE

10490 Mycetophagus punctatus Say, 9, June 1—Aug 22, Beaver Is, High Is, fungi
10491 Mycetophagus flexuosus Say, 3, June 1—Aug 9, Beaver Is, High Is
10509 Typhaea fumata L, 1, Aug 27, Beaver Is, on dead pine branch on ground
10511 Litargus tetraspilotus Lec, 7, Sept 7–9, Beaver Is, sifting debris on ground in pine woods

COLYDIIDAE

10598 Cerylon castaneum Say, 4, June 21—Sept 10, Beaver Is, High Is, under bark of rotten log

LATHRIDIIDAE

10699 Melanophthalma villosa Zimm, 16, July 8—Aug. 29, Beaver Is, Boyne City, Thumb Lake, herbage
10701 Melanophthalma distinguenda Com, 10, Aug 29—

Sept 9, Beaver Is, herbage, including Solidago, *Verbascum thapsus* and Erigeron, sifting debris on ground in pine woods

10705 MELANOPHTHALMA (CORTICARINA) GIBBOSA Hbst, 5, Aug 22—Sept 8, Beaver Is, Charlevoix, herbage including much Solidago

10712 MELANOPHTHALMA (CORTICARINA) AMERICANA Mann, 1, Sept 8, Beaver Is, herbage

ENDOMYCHIDAE

10720 LYCOPERDINA FERRUGINEA Lec, 2, Sept 14, High Is

10753 ENDOMYCHUS BIGUTTATUS Say, 12, Aug 21–24, High Is

PHALACRIDAE

10780 OLIBRUS SEMISTRIATUS Lec, 82, July 19—Sept 6, Beaver Is, Garden Is, Hog Is, Thumb Lake, herbage, mostly Solidago, two specimens under cover on beach

10812 ACYLOMUS PICEUS Csy, 1, Aug 29, Beaver Is, sweeping grass

10829 STILBUS APICALIS (Melsh), 2, Aug 23—Sept 8, Beaver Is, herbage

COCCINELLIDAE

10877 HYPERASPIS BIGEMINATA (Rand), 1, June 16, High Is, sweeping

10879 HYPERASPIS SIGNATA (Oliv), 2, June 8, Hog Is, beating

10930 HYPERASPIS UNDULATA (Say), 2, Aug 22, Charlevoix, herbage

11035 SCYMNUS PUNCTICOLLIS Lec, 6, June 5—Aug 29, Beaver Is, High Is, Thumb Lake, herbage

11055 SCYMNUS TENEBROSUS Muls, 15, July 18—Sept 10, Beaver Is, Thumb Lake, herbage, 13 specimens beaten from white pine

11147 COCCIDULA LEPIDA Lec, 1, July 17, Thumb Lake

11150 PSYLLOBORA VIGINTI-MACULATA (Say), 6, June 1—Sept 6, Beaver Is, beating cedar

11162 HIPPODAMIA TREDECIMPUNCTATA (L.), 11, July 8—Sept. 8, Beaver Is., High Is., Garden Is., Charlevoix, Thumb Lake, herbage, beach drift.

11163 HIPPODAMIA PARENTHESIS (Say), 17, June 7—Sept. 17, Beaver Is., High Is., Hog Is., Garden Is., Charlevoix, beach drift, herbage.

11173 HIPPODAMIA CONVERGENS Guer., 8, July 8—Sept. 17, Beaver Is., High Is., Hog Is., Charlevoix, Boyne City, herbage, beach drift, a pair *in copula* on Sept. 2.

11175 HIPPODAMIA QUINQUESIGNATA Kby., 6, June 1—Sept. 9, Beaver Is., beach drift, herbage, on milkweed.

11181 COCCINELLA PERPLEXA Muls., 6, June 7—Sept. 9, Beaver Is., High Is., beach drift, herbage, flowers of *Pastinaca sativa*.

11183 COCCINELLA TRICUSPIS Kby., 2, May 27—June 8, Hog Is., beating.

11184 COCCINELLA NOVEMNOTATA Hbst., 5, June 1—Sept. 9, Beaver Is., High Is., beach drift, flowers of *Pastinaca sativa*, on Erigeron and milkweed.

11187 COCCINELLA MONTICOLA Muls. (det. by Andrews), 2, July 8—Aug. 5, Garden Is., Boyne City, vegetation on beach.

11189 CYCLONEDA SANGUINEA (L.), 11, June 1—Sept. 8, Beaver Is., High Is., Charlevoix, beach drift, herbage.

11196 CLEIS PICTA (Rand.), 3, Sept. 9–10, Beaver Is., beaten from white pine.

11200 ANISOCALVIA DUODECIM-MACULATA (Gebl.), 1, June 1, Beaver Is., beating.

11201a ANISOCALVIA QUATUORDECIMGUTTATA SIMILIS (Rand.) (det. by Andrews), 1, July 7, Garden Is., beating.

11202 ANATIS QUINDECIMPUNCTATA (Oliv.), 5, July 7—Sept. 14, Beaver Is., High Is., Gull Is., Hog Is., beach drift.

11202a ANATIS QUINDECIMPUNCTATA MALI (Say), 4, June 1—Sept. 7, Beaver Is., Garden Is., under cover on beach.

11217 CHILOCORUS BIVULNERUS Muls., 2, June 2—Sept. 10, Beaver Is., High Is., beaten from white pine, at light.

ALLECULIDAE

11307 Isomira sericea (Say), 2, Aug 4–22, High Is
11311 Isomira quadristriata Couper, 13, June 14 — Aug 13, High Is, Garden Is, Hog Is, Gull Is, Thumb Lake, beating, on ground in hardwoods
11324 Mycetochara megalops Csy, 3, July 7 — Aug 22, High Is, at light

TENEBRIONIDAE

12207 Blapstinus metallicus (Fab) (det by Fletcher), 15, May 31 – Sept 1, Beaver Is, High Is, Gull Is, Trout Is, Thumb Lake, under cover on beach and on dry ground, on sand in gull rookery
12295 Bolitotherus cornutus (Panz), 24, July 21 — Sept 6, Beaver Is, Thumb Lake, fungi, one specimen in molasses trap in hardwoods
12305 Diaperis maculata Oliv, 8, May 15 — Sept 6, Beaver Is, High Is, Garden Is, fungi
12309 Hoplocephala bicornis (Fab), 11, Aug 9 — Sept 7, Beaver Is, High Is, nine specimens under single board on beach
12323 Platydema americanum Cast & Brll, 2, June 14 — Aug 22, High Is, under bark of *Pinus resinosa*
12390 Xylopinus saperdioides (Oliv), 2, Aug 24 — Sept 14, High Is
12405 Iphthimus opacus Lec, 38, June 6 — Sept 9, Beaver Is, Garden Is, High Is, Charlevoix, under rotten wood on beach and on dry sandy ground, abundant under rotten railroad ties in which it may breed
12407 Alobates pennsylvanica (DeG), 2, Aug 9, High Is
12411 Upis ceramboides (L), 3, May 16 — Aug 22, Beaver Is, High Is
12414 Tenebrio molitor L, 1, Aug 24, Beaver Is, at light in hotel
12415 Tenebrio picipes Hbst, 14, June 5 — Oct. 5, Beaver Is, High Is, under bark, under cover on dry sandy ground

LAGRIIDAE

12497 ARTHROMACRA AENEA (Say), 1, July 19, Boyne City, under stone on dry sandy ground

MELANDRYIDAE

12527 PENTHE OBLIQUATA (Fab), 3, Aug 21, High Is
12529 SYNCHROA PUNCTATA Newm, 7, June 5—Aug 11, High Is, at light, bred (June 13) from pupae taken under bark
12531 EUSTROPHINUS BICOLOR (Fab), 6, Aug 9–24, High Is
12536 SYNSTROPHUS REPANDUS (Horn), 5, Aug 2, High Is
12540 HALLOMENUS SCAPULARIS Melsh, 1, Sept 6, Beaver Is, under cover on dry sandy ground
12568 SERROPALPUS BARBATUS (Sch), 1, July 5, High Is
12570 DIRCAEA QUADRIMACULATA (Say), 3, June 8—Aug 2, High Is, Gull Is, under bark
12588 CANIFA PALLIPES (Melsh), 1, July 16, Thumb Lake, sweeping undergrowth in hardwoods

ANOBIIDAE

12717 TRYPOPITYS SERICEUS (Say), 4, Aug 2–17, High Is, at light
12855 CAENOCARA OCULATA (Say), 3, July 19, Thumb Lake, herbage

BOSTRICHIDAE

12902 BOSTRICHUS BICORNIS (Web), 1, July 8, Gull Is

CISIDAE

12972 CIS FUSCIPES Mellié, 2, Aug 9, High Is
12997 XESTOCIS LEVETTI Csy, 71, July 21—Sept 9, Beaver Is, Thumb Lake, bracket fungi

SCARABAEIDAE

13080 ONTHOPHAGUS HECATE Panz, 4, July 12—Sept 2, Bea-

ver Is , High Is , Thumb Lake, cattle dung, carrion, molasses trap

13098 Aegialia cylindrica (Esch), 1, June 1, Beaver Is , beach Listed from Washington and Alaska

13107 Aphodius (Teuchestes) fossor (L), 1, Sept 2, Beaver Is , cattle dung

13119 Aphodius fimetarius (L), 45, June 22 — Sept 7, Beaver Is , High Is , Boyne City, cattle dung

13123 Aphodius putridus (Hbst), 3, June 22, High Is

13184 Aphodius distinctus (Mull), 1, June 6, High Is , beach

13186 Aphodius leopardus Horn 2, Aug 23 — Sept 9, Beaver Is , High Is , horse dung, at sugar in evening

13239 Dialytes striatulus (Say), 5, Sept 9–10, Beaver Is , fungi, horse dung, carrion

13290 Geotrupes balyi Jek , 16, July 26 — Sept 9, Beaver Is , High Is , in road, carrion, horse dung, cattle dung

—— Serica cucullata Dawson, 4, July 12–18, High Is , at light

13364 Serica sericea (Ill), 10, June 14 — Aug 29, Beaver Is , High Is , Hog Is , Thumb Lake, herbage, on *Cornus stolonifera*, at sugar in evening, beach drift

13516 Lachnosterna anxia Lec , 1, July 21, High Is , at light

13517 Lachnosterna drakei Kby , 5, June 21 — July 18, High Is , Thumb Lake, at light, beach drift

13530 Lachnosterna rugosa (Melsh), 5, July 13–27, High Is , at light

13651 Dichelonyx subvittata Lec , 11, June 14 — Sept 5, Beaver Is , Garden Is , High Is , Hog Is , at light, sweeping and beating vegetation

13676 Dichelonyx albicollis Burm , 1, June 27, High Is

13769 Cotalpa lanigera (L), 1, Sept 6, Beaver Is , found dead on sand-dune

13834 Ligyrodes relictus (Say), 2, July 18, Thumb Lake, sweeping in marshy area

13902 Xyloryctes satyrus (Fab), 2, Sept 1, Beaver Is , beach drift

13940 EUPHORIA INDA (L), 1, Sept 7, herbage

14010 OSMODERMA SCABRA Beauv, 2, Aug 1–24, High Is

14012 OSMODERMA EREMICOLA Knoch, 1, Sept 3, Beaver Is, on tree trunk

14022 TRICHIOTINUS AFFINIS (G & P), 6, June 27—Aug 2, Beaver Is, High Is

TROGIDAE

13338 TROX UNISTRIATUS Beauv, 1, July 21, Thumb Lake, carrion

LUCANIDAE

14058 CERUCHUS PICEUS (Web), 1, June 5, High Is

CERAMBYCIDAE

14067 PARANDRA BRUNNEA (Fab), 1, Sept 3, Beaver Is, on tree trunk

14081 DEROBRACHUS (ORTHOSOMA) BRUNNEUS (Forst), 4, July 27—Aug 26, Beaver Is, High Is, Charlevoix, beach, at light, under cover on dry sandy ground

14097a TRAGOSOMA DEPSARIUM HARRISI Lec, 1, July 19, Gull Is, at light

14107 ASEMUM MOESTUM Hald, 3, June 1–14, Beaver Is, High Is, beach drift, sweeping, under bark of *Pinus resinosa*

14139 CRIOCEPHALUS OBSOLETUS (Rand), 6, June 21—Aug 23, Beaver Is, High Is, beach drift, at light

14311 CENTRODERA DECOLORATA (Harris), 1, July 12, High Is, at light

14403 ACMAEOPS PROTEUS (Kby) (?), 1, June 14, High Is, beach drift

14447 BRACHYLEPTURA CANADENSIS (Fab), 3, July 23—Aug 18, High Is, Hog Is, Squaw Is, beach drift

14466 STRANGALEPTA PUBERA Say, 1, June 23, High Is

14469 STRANGALEPTA VITTATA (Oliv), 11, June 23—Aug 9, Garden Is, High Is, Hog Is, beating

14487 STRANGALIA PLEBEJA (Rand), 5, July 26 — Aug 4, flowers of *Pastinaca sativa*

14508 STROPHIONA NITENS (Forst), 1, July 26, High Is

14516 LEPTURA (COSMOSALIA) NIGRELLA (Say), 4, June 28 — July 20, High Is , on cut pulp wood on beach Two of the specimens have light elytra

14520 LEPTURA (COSMOSALIA) CHRYSOCOMA Kby , 3, June 27 — July 8, High Is , Boyne City, vegetation on beach

14525 LEPTURA (CERCOLIA) PROXIMA Say, 4, July 8 — Aug 9, Garden Is , High Is , beating, flowers of *Pastinaca sativa*

14526 LEPTURA (CERCOLIA) MINNESOTANA Csy , 5, Aug 3–4, Garden Is , High Is , flowers of *Pastinaca sativa*

14532 LEPTURA (TRACHYSIDA) MUTABILIS Newm , 2, June 20–23, High Is

14532a LEPTURA (TRACHYSIDA) MUTABILIS LURIDIPENNIS Newm , 4, June 22 — July 7, High Is

14534 LEPTURA (TRACHYSIDA) PEDALIS Lec , 1, July 5, High Is

14540 TYPOCERUS ZEBRA (Oliv), 4, July 12 18, Thumb Lake, milkweed

14543 TYPOCERUS VELUTINA (Oliv), 9, June 27 — Aug 4, High Is , flowers of *Pastinaca sativa*

14574 DESMOCERUS PALLIATUS (Forst), 1, Aug 17, Nowland Lake

—— CALLIDIUM JANTHINUM Lec (?), 3, June 1, Beaver Is , on freshly cut cedar ties

14679 XYLOTRECHUS COLONUS (Fab), 4, July 19 — Sept 1, High Is , on cut pulp wood on beach

14691 XYLOTRECHUS UNDULATUS (Say), 8, June 14 — Aug 9, High Is , on cut pulp wood on beach

14728 ANTHOBOSCUS RURICOLA (Oliv), 5, July 7 — Aug 9, Garden Is , High Is

14741 CYRTOPHORUS VERRUCOSUS (Oliv), 11, June 8 — July 14, High Is , Hog Is , Garden Is , Gull Is , beating

14901 MONOCHAMUS NOTATUS (Drury), 1, Aug 11, High Is , at light

14904 MONOCHAMUS SCUTELLATUS (Say), 2, July 19 — Aug 3, Garden Is , High Is , on cut pulp wood on beach

14905 MONOCHAMUS MARMORATOR Kby, 2, July 19 — Aug 2, Beaver Is, High Is, on cut pulp wood on beach

15005 HYPERPLATYS MACULATA Hald, 2, July 7-14, Gull Is, High Is

15021 UROGRAPHIS FASCIATA (DeG), 1, Aug 21, High Is

15056 POGONOCHERUS MIXTUS Hald, 4, July 26 — Sept 5, Beaver Is, High Is, flying under pine tree

15113a SAPERDA CALCARATA ADSPERSA Lec, 1, July 8, Garden Is, on Populus

15122a SAPERDA POPULNEA MOESTA Lec, 3, July 7-23, Garden Is, Hog Is, High Is, beating

15162 TETRAOPES CANTERIATOR (Drap), 225, July 8-19, Boyne City, Thumb Lake mostly in beach drift, milkweed

CHRYSOMELIDAE

15223 SYNETA FERRUGINEA (Germ), 3, June 5 — July 7, High Is

15253 LEMA TRILINEATA (Oliv), 5, Aug 21, High Is, on ground-cherry

15297 CHLAMYS GIBBOSA (Fab), 6, July 8, Boyne City, vegetation on beach

15305 EXEMA GIBBER (Oliv), 19, Aug 22-24, Garden Is, Charlevoix, on Solidago

15433 PACHYBRACHYS OBSOLETUS Suffr (det by Frost), 2, Sept 9, Beaver Is, beaten from white pine

15472 MONACHULUS SAPONATUS (Fab), 6, July 8-19, Boyne City, Thumb Lake, herbage

15479a CRYPTOCEPHALUS NOTATUS QUADRIMACULATUS Say, 8, June 14 — Aug 29, Beaver Is, High Is, Norwood Township, herbage

15480a CRYPTOCEPHALUS QUADRUPLEX QUADRIGUTTULUS Suffr, 2, June 14-25, High Is, Hat Is

15495 CRYPTOCEPHALUS VENUSTUS Fab, 1, July 8, Boyne City, herbage

15521 DIACHUS AURATUS (Fab), 33, June 27 — Sept 8, Beaver Is, Garden Is, High Is, Boyne City, Norwood Township, herbage

15528 Diachus pallidicornis (Suffr) (?), 1, Aug 24, Beaver Is , herbage
15569 Graphops marcassitus Cr , 1, June 2, High Is
15573 Xanthonia decemnotata (Say), 1, July 18, Thumb Lake, beach
15604b Adoxus obscurus villosulus Schrank , 2, June 1, Beaver Is , beach drift
15627 Chrysochus auratus (Fab), 9, July 6–8, Thumb Lake, Boyne City, beach drift, milkweed
15635 Prasocuris phellandrii (L), 8, July 26, High Is
15639 Labidomera clivicollis (Kby), 2, July 19, Thumb Lake, marsh grass
15648 Leptinotarsus decemlineata (Say), 8, July 8 — Aug 24, Beaver Is , Charlevoix, Boyne City, Thumb Lake, beach drift, flying, herbage, molasses trap in hardwoods
15669 Calligrapha elegans (Oliv), 2, June 8, Hog Is , beating
15673 Calligrapha rowena Knab, 1, May 27, Garden Is , in grass
15674 Calligrapha philadelphica (L), 2, July 8, Boyne City, on Salix
15677 Calligrapha bigsbyana (Kby), 7, June 27 — Aug 1, Garden Is , High Is , Boyne City, Norwood Township, on Salix, beach drift
15708 Lina lapponica (L), 8, July 10–11, Beaver Is , on alder
15710 Lina scripta (Fab), 1, July 10, Beaver Is , on alder
15718 Phyllodecta vitellinae (L), 10, June 1 — July 30, Beaver Is , Garden Is , Hog Is , beach drift, on Salix
15726 Trirhabda virgata Lec , 7, July 19, Thumb Lake, vegetation on beach
15727 Trirhabda canadensis (Kby), 25, July 14 — Aug 29, Beaver Is , Garden Is , Gull Is , Thumb Lake, on Solidago
15744 Galerucella americana (Fab), variety without markings, 3, July 19 — Aug 1, Boyne Falls, Norwood Township; vegetation on beach
15745 Galerucella sexvittata (Lec), 1, Aug. 1, Norwood Township, vegetation on beach

15746 GALERUCELLA CAVICOLLIS (Lec), 5, May 29—June 23, High Is, Trout Is, Hog Is, beating

15752 GALERUCELLA TUBERCULATA (Say) (?), 1, Aug 29, Beaver Is, herbage

15769 DIABROTICA DUODECIMPUNCTATA (Fab), 32, May 27—Sept 8, Beaver Is, Garden Is, Hog Is, High Is, Charlevoix, beach drift, herbage, mostly Solidago

15782 DIABROTICA VITTATA (Fab), 7, May 27—July 26, Beaver Is, High Is, Hog Is, beach drift, herbage, on squash plant

15886 OEDIONYCHIS LIMBALIS Melsh, 4, June 2—Sept 8, Beaver Is, High Is, herbage

15896 DISONYCHA QUINQUEVITTATA (Say), 2, June 2-3, Hog Is, High Is

15901 DISONYCHA GLABRATA (Fab), 1, July 18, Thumb Lake, herbage near pond

15921 HALTICA ROSAE Woods (?), 3, June 9—Sept 1, Beaver Is, Whiskey Is, beach drift, herbage

15933 HALTICA CARINATA Germ, 3, July 5—Aug 29, Beaver Is, High Is, herbage

15968 CHALCOIDES HELXINES (L), 1, Aug 1, Norwood Township, vegetation on beach

15982 EPITRIX CUCUMERIS Har, 1, Aug 29, Beaver Is, herbage

16068 PHYLLOTRETA ROBUSTA Lec, 2, June 9, Whiskey Is, beach

PLATYSTOMIDAE

16299 EUPARIUS MARMOREUS (Oliv), 5, Aug 9, High Is

CURCULIONIDAE

16359 RHYNCHITES CYANELLUS Lec, 2, July 8, Boyne City, vegetation on beach

16678 BRACHYRHINUS OVATUS (L), 14, July 19—Sept 8, Beaver Is, Garden Is, Hog Is, Thumb Lake, herbage, under cover on dry ground and on beach, in molasses trap in hardwoods.

16728 SITONA HISPIDULUS (Fab), 24, Aug 22, Charlevoix, herbage, mostly Solidago

16767 LEPYRUS PALUSTRIS Scop (det by Andrews), 1, June 2, High Is

16778 LISTRONOTUS INAEQUALIPENNIS (Boh), 1, July 18, Thumb Lake, vegetation near pond

17300 PSEUDANTHONOMUS VALIDUS Dietz, 1, July 18, Thumb Lake, herbage

17339 ORCHESTES NIGER Horn (det by Buchanan), 1, Aug 25, Charlevoix, herbage

17345 ORCHESTES PALLICORNIS Say (det by Andrews), 1, June 5, High Is

17351 ACALYPTUS CARPINI (Hbst) (det by Buchanan and Andrews), 3, May 29—Aug 24, Garden Is, Whiskey Is, herbage

17359 GYMNETRON TETRUM (Fab), 6, July 21—Sept 6, Thumb Lake, on *Verbascum thapsus*, flying

17405 LIXUS RUBELLUS Rand (det by Andrews), 2, Aug 24, High Is

17646 LIMNOBARIS RECTIROSTRIS (Lec) 3, July 8, Boyne City, herbage

17877 CONOTRACHELUS POSTICUS Boh (det by Buchanan), 2, Sept 9–10, Beaver Is, under debris on ground in pine woods

17974 CRYPTORHYNCHUS LAPATHI (L), 2, Sept 14, Garden Is

18114 SPHENOPHORUS COSTIPENNIS Horn, (det by Andrews) 1, June 2, High Is

SCOLYTIDAE

18231 DENDROCTONUS VALENS Lec , 1, June 1, Beaver Is

18237 PHLOEOSINUS CANADENSIS Sw (det by Blackman), 2, Aug 22—Sept 8, Beaver Is, Charlevoix, under bark of dying cedar

18377. CRYPHALUS BALSAMEUS Hopk (det by Blackman), 21, Sept 1, Beaver Is, in dying balsam branch

18428 PITYOPHTHORUS PUBERULUS Lec (det by Blackman), 127, Aug 26—Sept 9, under bark of dying pine branches

18438 Pityophthorus canadensis Sw (det by Blackman), 2, Sept 9, Beaver Is , under bark of dying pine branch

18445 Pityophthorus granulatus Sw (det by Blackman), 4, Aug 26—Sept 1, under bark of dying pine and balsam branches

18446 Pityophthorus nudus Sw (det by Blackman), 1, Aug 27, Beaver Is , under bark of dying pine branch

18455 Pityogenes hopkinsi Sw (det by Blackman), 46, Aug 27—Sept 9, Beaver Is , under bark of dying pine branches

18488 Pityokteines sparsus (Lec) (det by Blackman), 17, Sept 8, under bark of dying balsam branches

18492 Orthotomicus caelatus (Eich) (det by Blackman), 3, Sept 8, under bark of dying pine branch

SUMMARY

	Species	Variety		Species	Variety
Cicindelidae	6	1	Helodidae	3	
Carabidae	121	1	Dermestidae	2	
Omophronidae	1		Byrrhidae	4	
Haliplidae	4		Ostomidae	2	
Dytiscidae	29		Nitidulidae	7	
Gyrinidae	5		Cucujidae	3	
Hydrophilidae	21		Erotylidae	2	
Silphidae	13		Byturidae	1	
Scydmaenidae	1		Mycetophagidae	4	
Staphylinidae	58		Colydiidae	1	
Pselaphidae	1		Lathridiidae	4	
Scaphidiidae	3		Endomychidae	2	
Histeridae	14	1	Phalacridae	3	
Lycidae	3		Coccinellidae	21	1
Lampyridae	7		Alleculidae	3	
Cantharidae	8		Tenebrionidae	11	
Melyridae	2		Lagriidae	1	
Cleridae	3		Melandryidae	8	
Corynetidae	1		Anobiidae	2	
Cephaloidae	1		Bostrichidae	1	
Mordellidae	7		Cisidae	2	
Meloidae	2		Scarabaeidae	23	
Pyrochroidae	3		Trogidae	1	
Pedilidae	2		Lucanidae	1	
Anthicidae	5		Cerambycidae	35	1
Elateridae	30		Chrysomelidae	41	
Melasidae	2		Platystomidae	1	
Throscidae	1		Curculionidae	15	
Buprestidae	10		Scolytidae	10	
Heteroceridae	2		TOTAL	580	5

THE JAMES MILLIKEN UNIVERSITY
DECATUR, ILLINOIS

THE LIFE-CYCLE AND GROWTH OF LAMPREYS

CARL L. HUBBS

I. INTRODUCTORY

So far as known, all species of lampreys (Petromyzonidae) spawn in small streams in the spring of the year, then die. In their development all pass through a prolonged and highly specialized larval period. The larvae, known as ammocoetes, are blind and toothless, and live like worms in the mixed sand and muck in the stream bottom. After having lived in such a manner for a certain number of years, the lampreys metamorphose into the adult stage.

After metamorphosis the life of the lampreys follows one of two courses. In one type of life-cycle, obviously the more primitive, the transformed lampreys retain a functional alimentary system and develop strong, sharp teeth. They feed in a semi-parasitic fashion on other fishes, and continue to live and grow, usually in the sea, or in lakes and larger streams. Having existed thus for an unknown period of time they re-ascend the smaller streams in spring migrations, spawn, die, and thus complete their life-cycle.

The lampreys of the contrasting life-history type entirely cease their feeding and growth after metamorphosis, which takes place in late summer or early fall (August to October). An entire period or element in the life-cycle is thus eliminated. The alimentary system rapidly degenerates into a non-functional condition. The teeth are reduced in size and particularly in sharpness, and in extreme cases variously decreased in number, or even fragmented. In this degenerate adult condition they continue to live, however, for a period of more than four but less than eleven months, unless prematurely destroyed. Having thus passed through the winter, they spawn in the following spring (March to June), then die, as do the parasitic species.

II THE ORIGIN OF THE DEGENERATE LAMPREYS

These degenerate dwarfs comprise several forms, each independently and perhaps even polyphyletically derived from a parasitic species On the basis of the most recent systematic revision of the Holarctic lampreys (Creaser and Hubbs, 1922), the origin and relationships of these forms may be illustrated diagrammatically (See Figure 16)

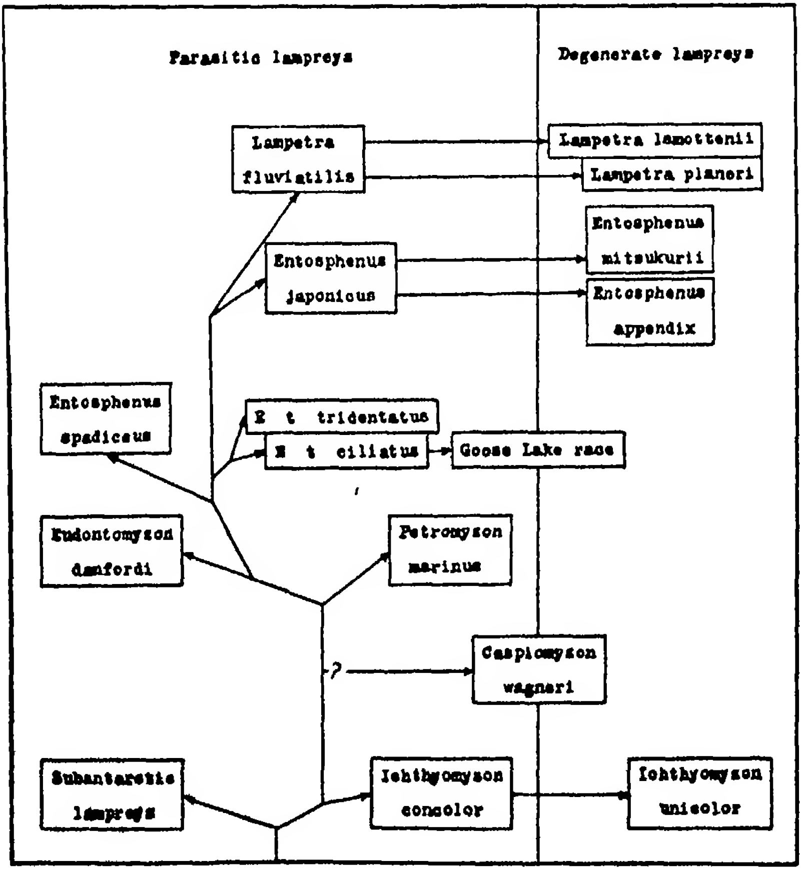


FIG 16. A Diagram of the Genetic Relationships of the Holarctic Lampreys

Ichthyomyzon unicolor (*I fossor* Reighard and Cummins), occurring in the Great Lakes-St Lawrence basin, is obviously the derivative of the common river lamprey, *Ichthyomyzon concolor*, or of a closely allied species

Caspiomyzon wagneri of the Caspian basin has rather degenerate dentition, but probably retains its parasitic habits, for it attains a considerable size Its position in the life-history classification here adopted is uncertain, on the diagram it is indicated as intermediate between the parasitic and the degenerate series

The southern subspecies (*E t ciliatus*) of the large sea-run lamprey of our Pacific Coast (*Entosphenus tridentatus*) is represented in Goose Lake, Oregon, by a race which seems to be in the process of degeneration Of a series of small adults, all taken on trout in this lake,[1] the *males* showed a decided approach toward the brook type of lamprey in the close approximation of the dorsal fins, relatively blunt teeth, atrophy of intestine and precocious sexual development The *females*, oddly, were not so altered, but resembled the normal parasitic young of the species Some specimens from Klamath Lake, not far distant from Goose Lake, but in a distinct stream system, also show evidence of degeneration

Entosphenus appendix (usually but wrongly called *Lampetra wilderi*) of eastern North America and *Entosphenus mitsukurii* of Japan were assuredly derived, probably independently, from the sea-run *Entosphenus japonicus*[2]

[1] Material collected by Barton W Evermann, examined by the writer in the United States National Museum

[2] Creaser and Hubbs (1922), lacking good material, were unable to distinguish between *E appendix* and *E mitsukurii* New material, collected for Doctor Jordan in Japan in 1922, and studied by Jordan and Hubbs, has shown that *mitsukurii* is usually the more degenerate in dentition and other respects, and differs from *appendix* further in having fewer myomeres and narrower (less palmate) oral fimbriae It is probable that brook types of *Entosphenus* occur throughout northern Siberia, but their systematic (and nomenclatural) relations with the American and Japanese forms cannot be satisfactorily determined at this time The Japanese specimens we identified as *Lampetra planeri* prove on reëxamination not to be that species, but rather *Entosphenus mitsukurii*

Similarly, *Lampetra planeri*, which ranges from Europe through Siberia to Alaska, and thence southward to central California, and *Lampetra lamottenii*, known only from the Ohio and Potomac basins of eastern North America, both seem to be degenerate relatives of *Lampetra fluviatilis* Of these two forms, *lamottenii* is much the more degenerate, and represents a distinct subgenus, *Okkelbergia* *Lampetra planeri* may even intergrade with *L fluviatilis* All of the brook lampreys are extremely variable in degree of degeneration

Most of the degenerate or brook lampreys, as indicated in the phyletic diagram, were apparently derived from the two parasitic species forming the terminus of what appears to be the main line of evolution of the holarctic lampreys This evolutionary line in fact seems to be leading toward the degenerate condition, being characterized by a decrease in body size, and by a reduction in the size of the mouth and in the number of teeth

III THE SIZE AT METAMORPHOSIS OF CERTAIN PARASITIC LAMPREYS

Concerning the life-cycle of the huge sea-run lamprey of the Atlantic, *Petromyzon marinus*, we have nothing to record, except some data on the small size at metamorphosis The largest ammocoete found in the extensive collection of the National Museum is 170 mm long, many others are between 130 and 157 mm long Recently transformed specimens taken in streams vary in length from 105 to 202 mm Of young taken in the sea, three, from Virginia Beach, are 137 mm in total length, and one taken from 25 fathoms, near Easter Point, is 138 mm long

Entosphenus japonicus also attains a large size, but metamorphoses when yet small The smallest adult examined is only 108 mm long The largest of a number of ammocoetes probably belonging to this species is 119 mm long Nothing more can now be recorded of the life-history of this lamprey

Adults of *Ichthyomyzon concolor* as small as 102 mm have been examined The species attains a length of at least 330 mm Data on the length of the adult life of this lamprey could probably be obtained

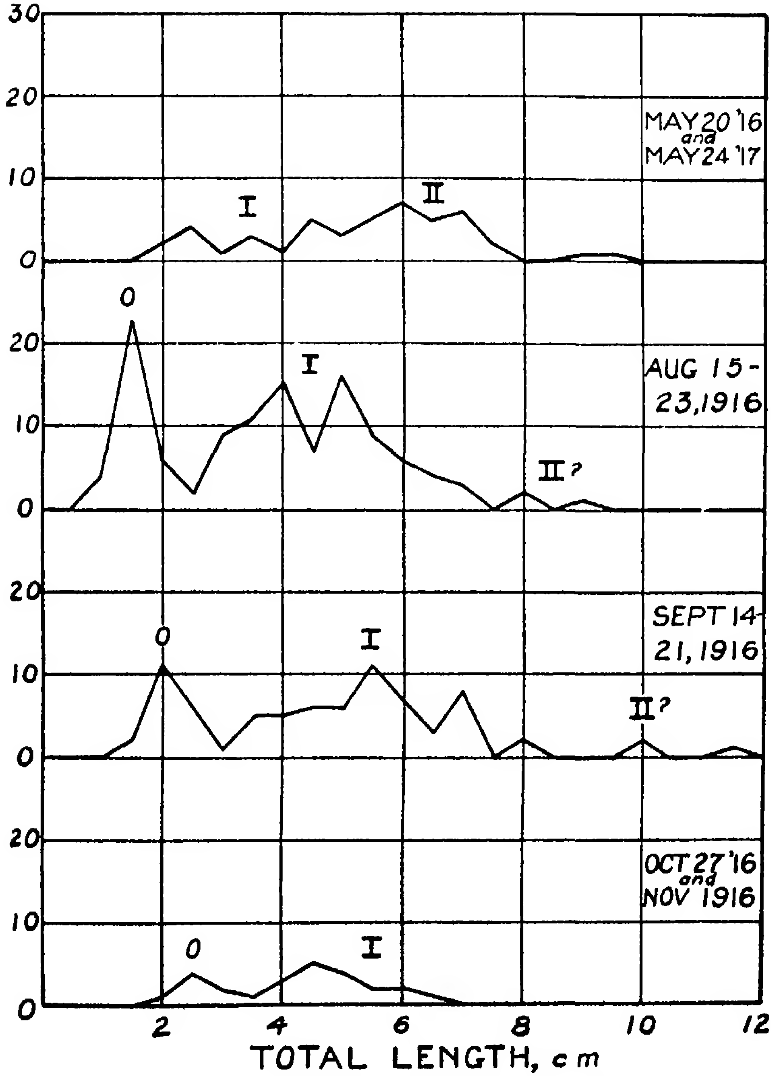


FIG 17 Size Frequency Curves for Ammocoetes of *Lampetra fluviatilis* (?)
Data from Meek (1917) Measurements to nearest half centimeter

IV THE LIFE-HISTORY OF *LAMPETRA FLUVIATILIS*

Meek (1917) has published measurements of series of English ammocoetes, which he has regarded as probably referable to *Lampetra fluviatilis*, the parasitic river lamprey According to the author, at least three or four generations are included in this material On regrouping and plotting the data, however, we find only two groups well marked, with a suggestion of a third The year groups are indicated on the graph (Figure 17) These figures, when considered in the light of similar but more extensive data on other species, indicate that the ammocoete period of this lamprey comprises at least three years

V THE LIFE-HISTORY OF *ENTOSPHENUS TRIDENTATUS*

Since so little is known of the duration of either the ammocoete or the adult stage in the life of any of the parasitic lampreys the following fragmentary evidence on the life-history of *Entosphenus tridentatus*, the sea-run lamprey of the Pacific Coast, is presented The material was collected in Coyote Creek, at San Jose, California

On May 23, 1923, one hundred and fifty-eight very small ammocoetes were dug out of this stream Their measurements form a compact frequency group (See Figure 18), with the mode at 14 mm and extremes at 9 and 21 mm As two species of lampreys occur in Coyote Creek, difficulty was encountered in identifying these young ammocoetes [3] Most of the specimens actually identified, including some of the largest and smallest, proved referable to *Entosphenus tridentatus*, a few only were found to be *Lampetra planeri* The frequency group is so compact, however, that 14 mm must be a close approximation of the average size of this year group for each species These speci-

[3] The identifications were based on the number of segments between the last gill opening and the end of the anal slit exhibited by each species in this stream In the *Entosphenus* this number varied from 67 to 76, usually from 70 to 74 This is an unusually high number for a southern population of this species, being quite as high as in the northern subspecies, *E t tridentatus*. In the Coyote Creek race of *Lampetra planeri*, the number of myomeres varies from 58 to 64, being most frequently 61

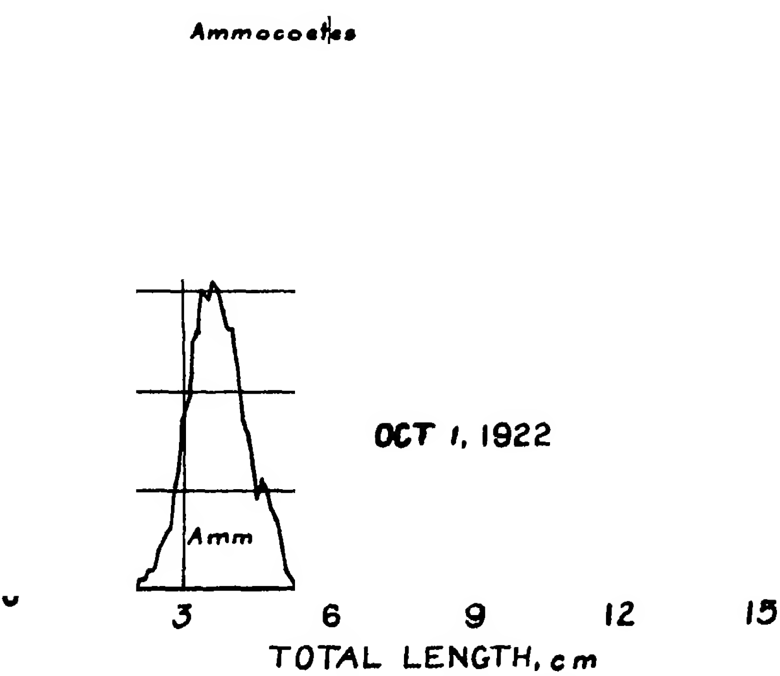


FIG 18 Size Frequency Curves for *Entosphenus tridentatus*

Samples from Coyote Creek California Actual data plotted for series of May 23 Measurements to nearest millimeter smoothed by fives for series of October 1 The smaller *ammocoetes taken May 23* include some specimens of *Lampetra planeri*. One transforming specimen taken October 1 is indicated on the graph

mens are without question the young of the year, not more than a few months old

On October 1, 1922, ninety ammocoetes of *E tridentatus* averaging distinctly larger (being 21 to 50 mm long, with the average at 37 mm) were taken at the same place These specimens, the lengths of which are also plotted on Figure 18, obviously comprise a single year group They appear also to represent the young of the year, but about four months older than those taken May 23 On that date a larva 75 mm long was secured It presumably was in its second year of life

On October 1, an incompletely transformed specimen, 141 mm long, was caught hiding under cover on the bottom from which the ammocoetes were dug Considering the slow growth of this species during the first season, and the comparative growth of other lampreys, including that of *Lampetra planeri* from the same stream (See Figure 19), we can regard this individual as probably in at least its third year of life The two other recently transformed specimens of this species examined are somewhat smaller one, taken on September 4 in the North Fork of Pitt River, California, is 138 mm long, the other, from Bear Creek, San Benito County, California, is only 100 mm long

From the scanty evidence available, it seems improbable that *Entosphenus tridentatus* metamorphoses before the fall of its third year Of the time of migration to the ocean, or of the duration of its adult life, nothing definite can be said Local differences in breeding size suggest that this period is variable

VI THE LIFE-HISTORY OF *LAMPETRA PLANERI*

Several efforts have been made to determine the number of years in the life-cycle of the degenerate brook lampreys, which spawn and die in the spring following their metamorphosis Müller early (1856) estimated the duration of life of the European brook lamprey as three years This estimate, however, is of only historical interest, having been based on only five ammocoetes and two transformed specimens

Lubosch (1903) also presented an estimate of the life-cycle

of *Lampetra planeri* According to him, this lamprey spawns in May By August the young have attained a length of 1 0 to 2 0 cm, specimens ranging to 5 cm in length are accredited to the first year of larval life, those 5 to 10 cm long, to the second year, no certain estimates, he thought, could be made for the third-year larvae The size of the ammocoetes before metamorphosis was given as 15 to 18 cm Although he offered no definite statement to that effect, Lubosch apparently considered the age at the completion of the life-cycle to be four years

Loman (1912) similarly claimed that the larvae in size are grouped about four distinct lengths He published no definite data, so far as we know, but we have received from Dr Loman eight specimens[4] representing the year groups which he recognized The lengths of these specimens for each estimated age are as follows

First-year larva	27 mm
Second-year larva	54 mm
Third-year larva	80 mm
Fourth-year larva	113 mm
Adults	87, 88, 89, 106 mm

It thus appears that Loman estimated the life span of *Lampetra planeri* as four years

The writer has obtained some data on the year groups and growth of a Californian lamprey which cannot be distinguished from *Lampetra planeri* (See Creaser and Hubbs, 1922) The material was collected in Coyote Creek, San Jose, California, with that of *Entosphenus tridentatus* (discussed above) The data are plotted as Figure 19

Spawning here apparently takes place earlier than in Germany or Holland, for the larvae of the year were found to be about 10 to 20 mm long on May 23 (1923)[5]

By October 1 (sample secured at the same spot in 1922), the young of the year had grown to a length of 34 to 74 mm,

[4] Material from Renkum Brook, Holland, collected August 5, 1911

[5] As already mentioned, the extreme young of *Lampetra planeri* and *tridentatus* could not be readily distinguished It was definitely ascertained, however, that both species were represented in the series of very small ammocoetes taken May 23

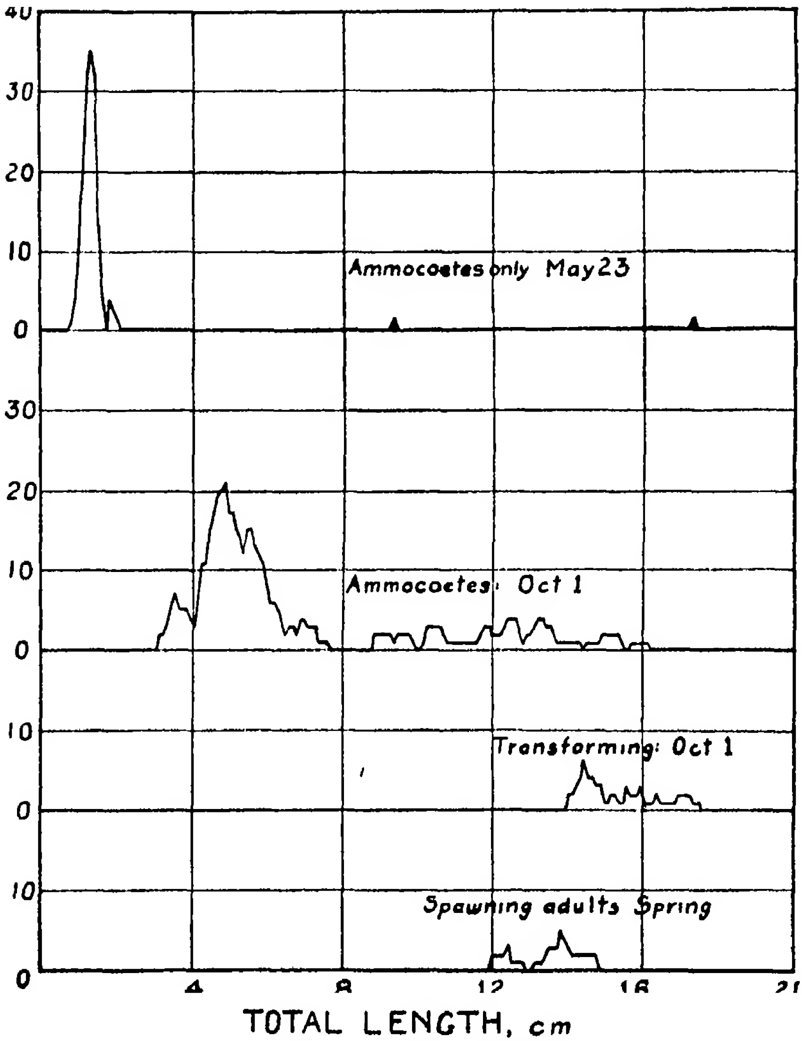


Fig 19 Size Frequency Curves for *Lampetra planeri*

Samples from Coyote Creek California Measurements "smoothed by fives" for all lots except that of May 23 Most of the smaller ammocoetes of this set are *Entosphenus tridentatus*

being mostly between 40 and 60 mm long The larva 94 mm long taken on May 23 must, therefore, have been more than one year old A still larger ammocoete taken on the same date, obviously about full-grown, being 172 mm long, was in all probability still older, or more than two years of age If these interpretations are correct, it would follow that the age at breeding and death would be not less than three years

By reference to Figure 19, it will be seen that this estimate is the minimum derivable from the data The larvae older than one year, and not yet metamorphosed, taken October 1, must represent at least one year class Being at least in their second year, they would not have metamorphosed before their third year, nor have spawned before the end of that year of their lives Whether this minimum estimate represents the correct value for the life span cannot be determined from the data, too few of the older ammocoetes having been obtained to permit of their analysis into year groups It is probable, however, that more than one, perhaps two, year classes are represented among these older ammocoetes, for the combined group shows a much greater dispersion than does the groups of ammocoetes almost at the end of their first year's growth, or the group of newly transformed individuals, or of spawning adults It is not improbable, therefore, that the life span of *Lampetra planeri* in both Europe and California is four years

A comparison of the size of the ammocoetes taken in both May and October with that of the recently transformed adults secured on the later date, and with that of spawning adults taken in the same place in the spring several years previous, suggests that a slight decrease in actual length accompanies metamorphosis and the attainment of maturity (See Figure 19) This situation is perhaps true of all lampreys, for adults are often found notably smaller than the largest ammocoetes Meek (1916) already has expressed his opinion that lampreys, like eels, may actually decrease in size during metamorphosis

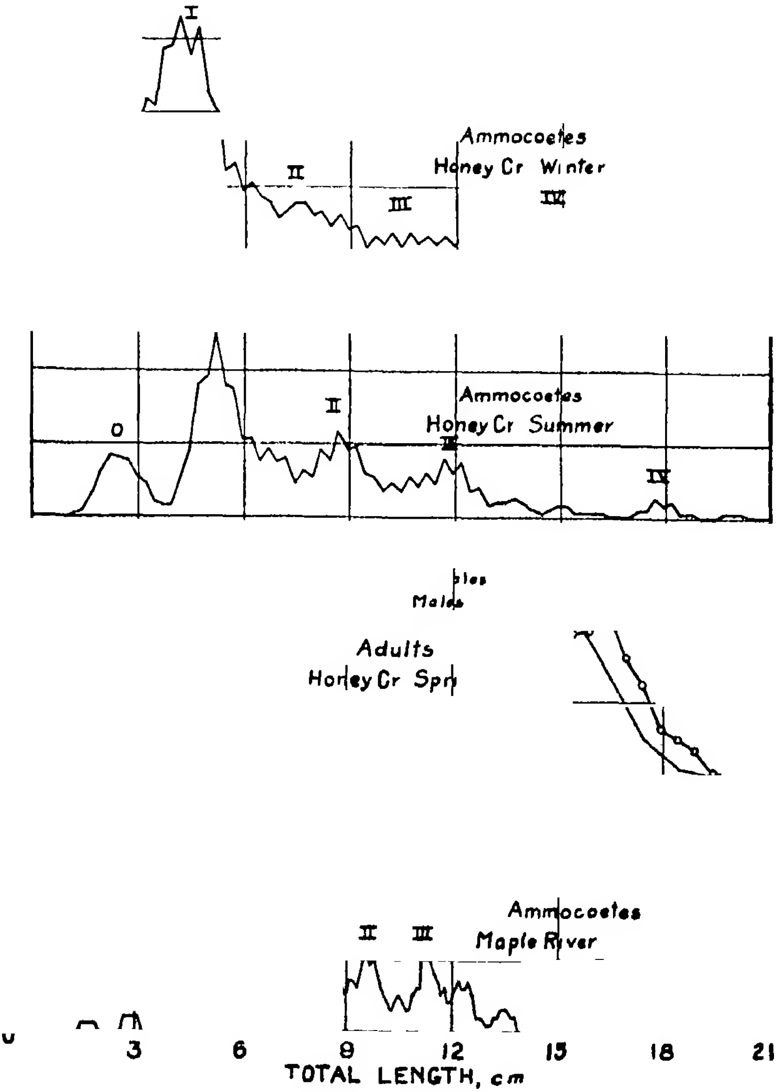


FIG 20 Size Frequency Curves for *Entosphenus appendix*

Measurements for first two graphs to nearest fourth of a centimeter smoothed by threes , for third graph measured to nearest half centimeter then smoothed by threes" for fourth graph, measured to nearest millimeter, then smoothed by fives '

VII THE LIFE-HISTORY OF *ENTOSPHENUS APPENDIX*

Okkelberg (1921) has estimated that another brook lamprey, *Entosphenus wilderi* (= *appendix*), lives five years before spawning and dying, five year groups of larva being represented in summer collections from Honey Creek, near Ann Arbor, Michigan Making use of Okkelberg's original data (for which privilege acknowledgement is here made), together with measurements of additional specimens from the same locality, the writer has found it possible to confirm this estimate (See Figure 20) A smaller series taken in Maple River, Michigan, on August 10, also furnishes confirmatory evidence three year groups appear to be represented, exclusive of the few young of year and of transforming individuals, none of which were secured (lowest graph, Figure 20) The life span of *Entosphenus appendix*, therefore, is apparently five years

The data on the growth of *Entosphenus appendix* in Honey Creek (Figure 20) seems sufficiently definite to admit of the presentation of a growth-curve for the species (See upper curve, Figure 22) As in most fishes, there is an early period of relatively rapid growth After the first year, that is, after the time of sex differentiation (Okkelberg, 1921), the growth is reduced in rate, but apparently accelerated again before metamorphosis In this way, a sigmoid growth-curve is produced, not unlike that of the sunfish (Creaser, MS) and of man In the lamprey, the curve is further complicated by the apparent shrinkage in actual size accompanying metamorphosis and the actual attainment of maturity

VIII THE LIFE-HISTORY OF *ICHTHYOMYZON UNICOLOR*

A still longer life later was indicated by Okkelberg (1922) for another degenerate brook lamprey of the Great Lakes region, *Ichthyomyzon unicolor* Okkelberg's data are replotted on a different statistical basis as the upper two curves of Figure 21 The frequency curve for the Thunder Bay series agrees well with Okkelberg's in apparently showing seven year groups of ammocoetes The curve for the Gilchrist Creek set shows similar but

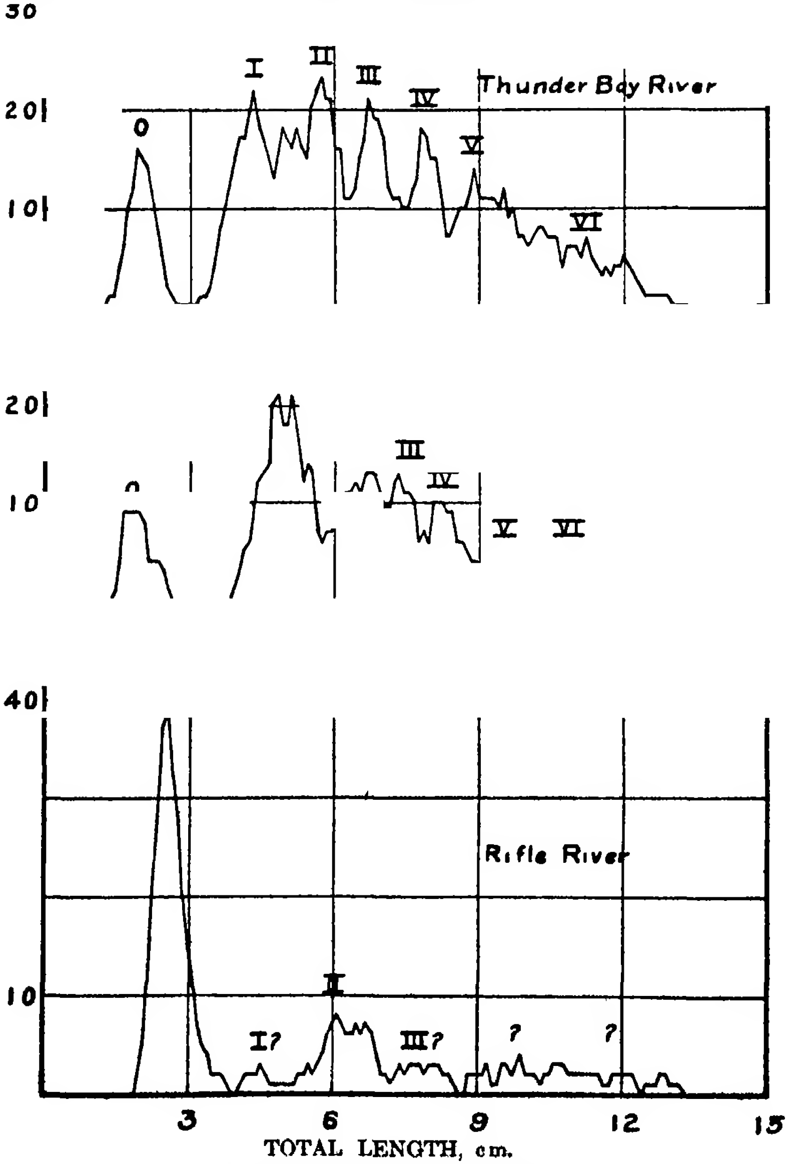


FIG 21 Size Frequency Curves for *Ichthyomyzon unicolor*
Measurements made to nearest millimeter then ' smoothed by fives '

less distinct modes, probably because of the smaller number of specimens secured The curve for one hundred and two ammocoetes taken in Rifle River, another Michigan stream, on August 27 (lowest graph, Figure 21), is still less definite Okkelberg was apparently right in estimating the life span of this brook lamprey as seven years

The growth curves drawn up from the data for the Thunder Bay River and Gilchrist Creek lots of *Ichthyomyzon unicolor* (Figure 22) are similar in form to the curve for *Entosphenus appendix*, although growth after the first year is more retarded, and the life more prolonged There is indicated, as in that species, a rather rapid early growth, then a prolonged period of retarded growth apparently somewhat accelerated before metamorphosis, and perhaps an actual decrease in size accompanying transformation

IX SUMMARY

All lampreys, so far as known, pass through a prolonged ammocoete period, during which they live, blind and toothless, in the stream bottoms After metamorphosis the life follows one of two types In the one type of life-cycle, the adult lampreys feed semi-parasitically on other fishes, and continue to grow for an unknown period before spawning and dying In the other type, feeding and growth cease at the time of transformation, breeding then ensues the following spring, then death The degenerate or brook lampreys appear to have been independently derived from different parasitic species (Figure 16)

The large parasitic lampreys transform at a small size, but probably not, in the cases in which evidence is presented, until an age of at least three years is attained (Figures 17 and 18) The length of life of the degenerate lampreys is variable, but probably comprises at least three years in all species The probable life span for the three species studied is for *Lampetra planeri*, four years (Figure 19), *Entosphenus appendix*, five years (Figure 20), for *Ichythyomyzon unicolor*, seven years (Figure 21)

The growth of *Entosphenus appendix* and of *Ichthyomyzon unicolor* is fairly rapid during the first year, then retarded for

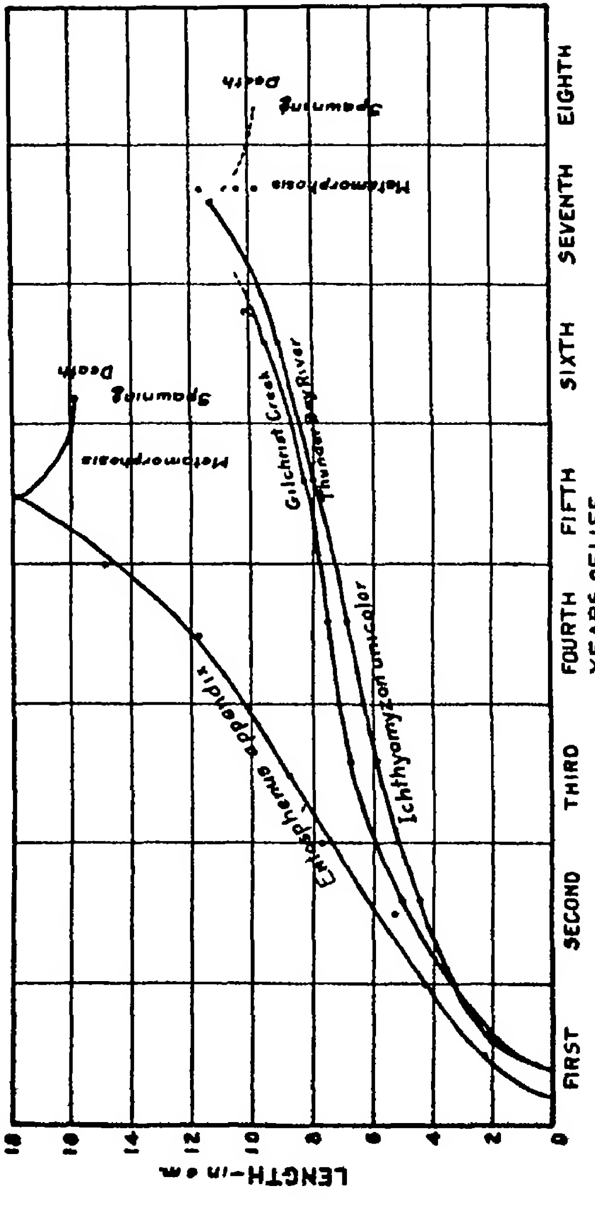


FIG. 22. Growth Curves for Two Species of Lampreys
Data obtained from figures 20 and 21

several years, but apparently somewhat accelerated before metamorphosis (Figure 22) An actual decrease in the size of lampreys probably accompanies metamorphosis and the attainment of maturity

UNIVERSITY OF MICHIGAN

LITERATURE CITED

CREASER, CHARLES W AND CARL L HUBBS 1922 A Revision of the Holarctic Lampreys Occ Pap Mus Zool, Univ Mich, No 120, pp 1–14

LOMAN, J C C 1912 Über die Naturgeschichte des Bachneunauges Lampetra planeri (Bloch) Zool Jahrb, Suppl 15, 1 243–269

LUBOSCH, W 1903 Über die Geschlechtsdifferenzierung bei Ammocoetes Verh Anat Ges, Vers, 17 66–71

MEEK, ALEXANDER 1916 The Migrations of Fishes Edward Arnold, London 427 pp

—— 1917 The Lampreys of the Tyne Rep Dove Mar Lab, N S, 6 49–51

MULLER, A 1856 Über die Entwicklung der Neunaugen Arch Anat Phys Wiss Med, 1856, p 323

OKKELBERG, PETER 1921 The Early History of the Germ Cells in the Brook Lamprey, *Entosphenus wilderi* (Gage), up to and including the period of sex differentiation Journ Morph, 35 1–151

—— 1922 Notes on the Life-history of the Brook Lamprey, *Ichthyomyzon unicolor* Occ Pap Mus Zool, Univ Mich, No 125, pp 1–14

NOTES ON SOME MICHIGAN SNAKES *

T H LANGLOIS

SINCE the life-histories and habits of most snakes have been but imperfectly recorded, my observations of the past summer may constitute an acceptable contribution It was originally intended to continue these studies, but this has become impossible, and these notes are offered now in their admittedly fragmentary form This work was done between July 2, and August 23, 1923, at the University of Michigan Biological Station The writer wishes to express his appreciation to Professor George R La Rue for the facilities offered by the Biological Station, and to Dr Frank N Blanchard for assistance during the progress of the study

The snakes collected and observed during this period were as follows

17 ring-neck snakes, *Diadophis punctatus edwardsii* (Merrem)
8 green snakes, *Liopeltis vernalis* (Harlan)
17 water snakes, *Natrix sipedon sipedon* (Linné)
3 red-bellied snakes, *Storeria occipito-maculata* (Storer)
13 ribbon snakes, *Thamnophis sauritus sauritus* (Linné)

DIADOPHIS PUNCTATUS EDWARDSII — Until recently ring-neck snakes have been considered rather rare in this region Ellis (1917, p 49) states that he has seen four specimens collected beneath fallen timber in the vicinity of North Fishtail Bay, Douglas Lake, in the summers of 1914 and 1915 Dr F C Gates and Dr J H Ehlers found a dead specimen in the sandy road between Cecil Bay and Big Stone Bay, Emmet County, near the shore of Lake Michigan on August 19, 1916 There are a few additional records of single specimens found in Cheboygan County, near Douglas Lake

The idea of rarity was somewhat shaken when the writer

* Contribution from the Biological Station of the University of Michigan.

found nine ring-neck snakes under one board at Big Stone Bay, Emmet County, August 3, 1921 Certain features connected with this find, and with others to be mentioned, offer a possible explanation for the apparent rarity of these snakes The nine snakes were found in an open field near a second-growth coniferous woods On August 4 two more were found under the same board, and two small specimens beneath separate boards near by The last one was taken under the large board on August 8 A peculiar feature was that the snakes found under the large board were bunched beneath two pieces of tar paper, eight inches square, with bodies closely intertwined When the snakes were brought into the laboratory, tar paper was placed in their terrarium, and, although they had a choice of sphagnum, bark, board and tar paper, they were most frequently found beneath the tar paper Light and contact conditions were controlled as much as possible, so as to make it truly a choice of material

A little later in the summer, August 12, Dr Blanchard found three adult ring-neck snakes in a small pile of old white cedar bark near Reese's Bog, on Burt Lake, Cheboygan County The same collector reports two ring-neck snakes found under the loose bark of a fallen hemlock tree in a small stand of beech and maple woods near Bryant's Hotel on Douglas Lake, September 3, 1918 Ditmars (1908, p 335) records finding this species mainly beneath the resinous bark of hemlock trees

It would seem that the apparent rarity of ring-neck snakes in this region, and possibly in others, could be accounted for by their gregarious tendency (Hurter [1910, p 189] records finding seventeen ring-neck snakes, *D punctatus arnyi*, beneath a flat rock two feet by eighteen inches), and by their preference for concealment under resinous substances Possibly tar paper could be used as a trap in the field

But little information was obtained on their habits and food In the terrarium they remained in concealment and nearly motionless throughout the daytime, but became active after dark They declined red-backed salamanders (*Plethodon cinereus*) which were offered as food However, a specimen examined fresh from the field contained the remains of one Surface (1906, p 136) also records the ring-neck snake as feeding upon this salamander

LIOPELTIS VERNALIS — Three gravid female green snakes were taken and kept for their breeding records, two from Douglas Lake, Cheboygan County, and one from Cecil Bay, Emmet County Two of them laid their eggs on August 14, one laying three eggs, the other four The third and largest was collected on August 15, and, although her abdomen was quite as distended as the others had been, she retained her eggs and must have resorbed them, as her abdomen was of normal girth about October 1 The eggs were cylindrical, with rounded ends and were encased in a white leathery covering They ranged in length from 27 to 38 mm and averaged about 12 mm in diameter at the middle, 10 mm at one end, and 11 mm at the other The covering was stretched smooth and tight except in one which bore a wrinkle between its middle and its larger end, and another which was spoiled When the latter was opened the dead embryo, measuring 86 mm, was found to be occupying a cavity in the middle of the egg, with yolk at both ends

The six good eggs were kept on moist sand, and covered with sphagnum All six hatched on August 28 Before hatching the egg-covering was fully distended until the crack appeared The latter extended crosswise in the middle of the egg for a distance of 4 or 5 millimeters As the egg broke a colorless fluid issued, and in about half an hour the young snake partially emerged In no case did it crawl entirely out at its first appearance When it had as much as two inches of its length out of the egg the young snake would quickly withdraw into its covering if alarmed In each instance, after several emergences and withdrawals, occupying from one to four hours, the final escape was accomplished with a slight jerk, perhaps due to the breaking of the yolk-stalk attachment No egg-tooth could be seen with the unaided eye on any of the young snakes, and they did not shed their skins soon after hatching

NATRIX SIPEDON SIPEDON — Eleven female water snakes were collected near Douglas and Burt Lakes from July 4 to August 21 Two of these were immature, and the other nine had embryos in their oviducts The collection of these at various dates gave a series of embryos of sizes increasing with the advance of the season, as follows

July 4 — No embryos visible
July 10 — Embryos about 75 mm long
July 11 — Embryos about 52 mm long
July 18 — Embryos about 75 mm long
July 18 — Embryos about 75 mm long
July 27 — Embryos about 146 mm long
Aug 21 — Embryos about 180 mm long

The 52 mm and the 75 mm embryos had well defined scales and scale rows, but were colorless The 146 mm and the 180 mm embryos were definitely colored with four distinct rows of dorsal blotches

Only a very general relationship was noted between the length of the adult and the number of young The figures are as follows

Length of adults in centimeters	Number of embryos
72	21
85	16
90	15
90	30
93	23
93	23
96	28
105	18
1135	45

In every case there were more embryos in the right than in the left oviduct, and, although there was some dovetailing, the embryos in the left oviduct, with but one exception, were closer to the vent than those in the right oviduct

Two of the water snakes had fish in their stomachs and one had a leopard frog Four of the stomachs were infested with Ascarid worms

Storeria occipito-maculata — On July 25 a gravid female red-bellied snake was found lying in a sandy road near Mud Lake, Cheboygan County, by Dr Minna Jewell A second female of this species in the same condition was picked up on August 3 in a sandy path at Big Stone Bay, Emmet County, by Dr George E Nichols. Still a third gravid female was found on August 9 beneath a board in a clearing at Cecil Bay, in Emmet County, by Dr F N Blanchard All three were given to the

writer by the collectors, and were kept until their young were born

The first female bore nine young on August 20 The first of her young ones was discovered at 11 20 A M and had been born not more than a few minutes, as it was still in the egg-membrane Five more were born between 12 00 and 12 40, the seventh at 12 48, the eighth at 1 16, and the last at 2 16 The young were forcibly ejected by a continuous series of muscular body constrictions passing from the head to the vent of the mother The birth of one of the young ones required four minutes from its first appearance in the vent to its complete separation from the parent Others, for various reasons, took longer When the head-fold was pointed posteriorly the time for emergence was shortened, since the young one was thus enabled to help himself out The last one to be born had its head folded a short way back, but it broke the egg-membrane, straightened out its neck, and explored actively with its tongue while still in the vent The mother's belly was not concave when the young were all out, but the skin was wrinkled along the sides of the body, whereas before it had been stretched tight For about thirty-six hours after the last of her brood was born the mother remained practically motionless She paid no attention to a slug that crawled about her, although slugs are well known to be a favorite food of the species

The second female gave birth to her six young on August 21, and the third female to her eight young on September 4 The young averaged 84 millimeters in length The individual measurements in millimeters were 83, 84, 89, 82, 83, 81, 86, 84, and 86, 82, 83, 87, 81, 81 Their backs were fuscous-black, their occipital spots light salmon-orange, and their bellies orient-pink These colors were uniform in all three broods, though the backs of the mothers were notably different The first adult's back was hair-brown, that of the second chestnut, and of the third auburn, making a striking color series The bellies of all three were English red [1]

THAMNOPHIS SAURITUS SAURITUS — A female ribbon snake dis-

[1] All colors correspond with Ridgway's *Color Standards and Nomenclature*

sected August 1 contained seven embryos, four in the right oviduct and three in the left Each embryo was 195 millimeters long, and was accompanied by a considerable amount of yolk A female opened August 6 contained nine embryos, without visible yolk, each 225 millimeters long These embryos were apparently ready to be born, and, since the mother had been opened immediately after etherization, the young were still alive When the oviduct was opened the young ones became active almost immediately, and one even crawled out of the oviduct They paid no apparent attention to their mother, and exhibited an absolute independence from the first Within ten minutes of his birth one of them struck vigorously at a teasing finger, and excreted his musk when picked up The musk was colorless and nearly odorless All of them shed their skins within an hour after birth Two days after their abnormal birth a spring-peeper (*Hyla crucifer*) was dropped into their terrarium, and in about an hour one of the young snakes had it stuck in his throat However, the frog was too large, and he loosed his hold when disturbed

The young ranged in length from 66 millimeters to 77 millimeters, with an average of 70 millimeters They were, in color and proportion, similar to the adult

BIBLIOGRAPHY

Blanchard, F N 1922 The Amphibians and Reptiles of Western Tennessee Occ Pap Mus Zoöl, University of Michigan, No 117, pp 1–18

Ditmars, Raymond E 1908 The Reptile Book Doubleday Page & Co New York 472 pp

Ellis, Max M 1917 Amphibians and Reptiles of the Douglas Lake (Michigan) Region Rep Michigan Acad Sci, 19 45–63

Hay, O P 1892 On the Breeding Habits, Eggs and Young of Certain Snakes Proc U S Nat Mus, 15 385–397

Hurter, Julius, Sr 1910 Herpetology of Missouri Trans Acad Sci St Louis, 1911, pp 59–274

Ridgway, Robert 1912 Color Standards and Color Nomenclature

Ruthven, A G 1912 The Reptiles of Michigan Michigan Geol and Biol Surv, Publ. 10, Biol Ser 3, pp 63–160

Surface, H A 1906 The Serpents of Pennsylvania. Pennsylvania State Dept Agri, Div Zoöl, Mo Bull, Aug and Sept, pp 114–208

NOTES ON THE BIRDS OF CHARLEVOIX COUNTY AND VICINITY

JOSSELYN VAN TYNE

During the summer of 1923, the writer served as assistant on an expedition to Charlevoix County to study the mammals of that region This work was supported by the Michigan Department of Conservation The study of the distribution of the mammals carried the party frequently to all parts of the county, and the writer made the best of the opportunity to study the birds of this little known region As nothing seems to have been published on the birds of the mainland of Charlevoix County, the following notes are submitted with the hope that they may serve as a basis for further work on the birds of this interesting country

We arrived on June 20 at the farm near Boyne Falls which was to be our base for the summer This was two miles southeast of Boyne Falls From this point and from temporary camps in Norwood Township and in Young State Park, the county was covered pretty thoroughly by automobile The week from July 9 to 13 was spent at "King's Camp" in the eastern part of Montmorency County (Sec 30, T 32 N , R I E) and from July 23 to 28 we worked on Marion Island in Grand Traverse Bay The rest of the summer until August 26 was spent in Charlevoix County From that date until September 2, we camped about four miles south of Elmira in order to collect in the virgin hardwood forest there

In addition to my own notes, much use has been made of those of my fellow assistant, Aldred S Warthin, Jr To T H Hubbell I am indebted for the identification of insects found in some of the birds' stomachs In 1922, N A Wood, curator of the Museum of Zoölogy, University of Michigan, was in the re-

gion from August 7 to 30, and has kindly permitted me to use his notes Other valuable notes have been sent me by W E Hastings, custodian of birds' eggs in the Museum of Zoölogy Finally, I wish particularly to thank L R Dice of the Museum of Zoölogy, without whose generous encouragement and assistance the work would have been impossible

As far as possible with the material at hand, an attempt has been made to record the numbers and habitat distribution of the various species The first of these is, of course, an extremely difficult matter The apparent numbers are largely dependent upon whether the bird is conspicuous or not, and the personal factor is so great that such brief notes on abundance as can be given here must necessarily be rather indefinite To make it as exact as possible, a definite scale of relative abundance has been used in these notes (i e , abundant, common, numerous, few, rare)

The only excuse for presenting such meagre notes on habitat preferences as are here included under many species, lies in the fact that the birds of the region have never before been studied from this point of view and it may be long before further work is done In the meantime, conditions are changing rapidly and even now but little of the country is left in its original condition When Brewster and Dwight made a collecting trip to this region only thirty-five years ago, the county was still largely covered with the original forest. Now the last few sections are being cut

The following is a list of the bird habitats mentioned here

Open-water
Bulrush
Tamarack and black spruce bog
Swamp brush
Sand beach
Dune heath
Aspen
Hardwood forest
Pine barren
Pasture
Orchard
Edificarian
Mud-flat
Stream-border
Arbor vitae swamp
Second-growth fir and spruce forest
Gravel beach
Dry brush
Second-growth hardwood forest
Jack pine forest
Aerial
Cultivated field
Ruderal

In general the names are self-explanatory, but more complete descriptions of these habitats are being published by L R Dice in his paper on the mammals of the region, which is to appear in the *Occasional Papers of the Museum of Zoölogy, University of Michigan* For the sake of uniformity and to avoid duplication of the habitat descriptions, the same nomenclature of the habitats is used here as by Dice The mud-flat habitat is added because of its importance to the shore birds

All of the one hundred and eighteen species in the following list are here recorded from Charlevoix County, except the upland plover and the wood thrush The annotated list is primarily an account of the Charlevoix County birds and all notes apply to that county except when other localities are particularly named All of the observations recorded here were made by the writer in the summer of 1923 unless otherwise specifically stated, in which case the year and authority are always given The nomenclature used is that of the *A O U Check List* (1910) with its supplements The specimens collected are in the Museum of Zoölogy, University of Michigan

ANNOTATED LIST

PODILYMBUS PODICEPS (Linn) Pied-billed grebe — One was seen on Deer Lake, August 8, 1922, by N A Wood

GAVIA IMMER (Brünn) Loon — Two were seen at Thumb Lake, July 17 and 20, and a flock of six was observed off Fisherman's Island, August 10, 1923 W E Hastings noted two at Norwood, November 21, 1910

LARUS ARGENTATUS ARGENTATUS Pont Herring gull — Common on Lake Michigan and Pine Lake and numerous on the smaller lakes

LARUS DELAWARENSIS Ord Ring-billed gull — On August 8, 1923, A S Warthin, Jr noted one at Fisherman's Island in company with herring gulls

STERNA CASPIA IMPERATOR (Coues) Caspian tern — Two to seven were seen daily at Fisherman's Island, August 7 to

10, 1923, and one on Pine Lake at Young State Park, August 18 This species is doubtless of regular occurrence along the Lake Michigan shore, as it breeds in some numbers on the Beaver Islands

STERNA HIRUNDO Linn Common tern — Numerous along the Lake Michigan shore

CHLIDONIAS NIGRA SURINAMENSIS (Gmelin) Black tern — W E Hastings records this bird at Charlevoix, June 14, 1923

MERGUS AMERICANUS (Cassin) American merganser — Seen at Norwood, November 21, 1910, by W E Hastings

MERGUS SERRATOR Linn Red-breasted merganser — A female merganser, probably of this species, with eight half-grown young, was seen on the Boyne Falls mill-pond July 31, 1923 W E Hastings reports the species at Norwood, November 21, 1910 A nest with eleven eggs was found on Marion Island, Grand Traverse Bay, July 24, 1923 The nest was placed on the ground close under the floor rafters of a deserted dance pavilion about a hundred feet from the water Nearly a dozen females were constantly seen about the island and doubtless had nests there Only an occasional male appeared with them

ANAS PLATYRHYNCHOS Linn Mallard — A female was seen off Fisherman's Island, August 10, 1923

ANAS RUBRIPES Brewster Black duck — One was noted at Fisherman's Island, August 10, 1923

MARILA AFFINIS (Eyton) Lesser scaup duck — Walter E Hastings found flocks of thousands along the Lake Michigan shore at Norwood, November 21, 1910

GLAUCIONETTA CLANGULA AMERICANA (Bonap) American golden-eye — W E Hastings reports this species also as very abundant near Norwood, November 21, 1910

CHARITONETTA ALBEOLA (Linn) Bufflehead — Six birds noted near Norwood on November 21, 1910, by W E Hastings

BOTAURUS LENTIGINOSUS (Montagu) Bittern — Only three were seen during the summer in Charlevoix County

ARDEA HERODIAS HERODIAS Linn Great blue heron — At

Thumb Lake and along the Lake Michigan shore, single birds were seen regularly in 1923, but rarely elsewhere

RUBICOLA MINOR (Gmelin) Woodcock — In late July and early August, at least, the woodcock seemed to be rather numerous in the very wet willow alder thickets at the Boyne Falls mill-pond

PISOBIA MINUTILLA (Vieill) Least sandpiper — This species was seen by N A Wood, August 22, 1922, at Deer Lake

EREUNETES PUSILLUS (Linn) Semipalmated sandpiper — Noted at Deer Lake, August 22, 1922, by N A Wood

TOTANUS FLAVIPES (Gmelin) Lesser yellowlegs – First seen August 12, 1923 From August 15 to 17 there were flocks of a dozen or less on the mud flats of the Boyne Falls mill-pond

TRINGA SOLITARIA SOLITARIA Wilson Solitary sandpiper — A female collected near Thumb Lake, July 18, 1923, was found to be extremely fat, weighing 72 7 grams An interesting contrast to this was afforded by another female (Boyne Falls, August 15) without noticeable fat, found to weigh forty-six grams A flock of fifteen appeared at the Boyne Falls mill-pond on August 16, but the pond was later filled with water and no shore birds were seen after this date

BARTRAMIA LONGICAUDA (Bechst) Upland plover — Not seen in Charlevoix County In Otsego County an adult with a young one about a week old was found in a very dry and desolate part of the pine-barren country a half-mile west of Round Lake (Sec 29, T 32 N , R I W) on July 9, 1923

ACTITIS MACULARIA (Linn) Spotted sandpiper — Numerous in 1923 on the sand shore near Fisherman's Island and on the inland lakes of Charlevoix County Common on Marion Island, where young well able to fly were seen July 24

OXYECHUS VOCIFERUS (Linn) Killdeer — Common in the pasture and sand beach habitats, few in the cultivated fields and gravel beach

This species bred commonly in the pasture lands, but in the latter part of the season was found more commonly along shore Young nearly able to fly were noted at Thumb Lake July 19 and 21

COLINUS VIRGINIANUS VIRGINIANUS (Linn) Quail — N A Wood noted several near Charlevoix during the latter half of August, 1922 On June 14, 1923, W E Hastings also found quail near Charlevoix During the summer of 1923 but one was seen and this near Boyne Falls on June 22 (A S Warthin, Jr)

BONASA UMBELLUS TOGATA (Linn) Canada ruffed grouse — Abundant in dry brush, swamp brush, common in arbor vitae swamp, second-growth fir and spruce forest, numerous in hardwood forest, few in aspen, jack pine forest, and second-growth hardwood forest The species was studied in Charlevoix County in all of the foregoing habitats except the jack pine forest This habitat was studied only in the eastern part of Otsego County

A male was collected July 3, in Boyne Valley Township, and three more birds were kindly collected for me in Melrose Township by J H Stephenson on October 28 These birds have been examined by J L Peters of the Museum of Comparative Zoology of Harvard University, who considers that, while they are not absolutely typical *togata*, yet they are distinctly referable to this subspecies rather than to *umbellus*

The grouse were rather common throughout the region Three separate broods of young about three weeks old were seen between June 22 and 25, which probably indicates the usual nesting dates Adult birds with young continued to be seen during the summer Ten young seen July 2 constituted the largest brood noted

ZENAIDURA MACROURA CAROLINENSIS (Linn) Mourning dove — Numerous in a large arbor vitae swamp in Boyne Valley Township, but few were seen elsewhere

CIRCUS HUDSONIUS (Linn) Marsh hawk — Numerous, especially in the arbor vitae swamps and in open cultivated country.

ACCIPITER VELOX (Wilson) Sharp-shinned hawk — Rare Reported in the county by N A Wood, August 17, 1922 On July 13, 1923, one was seen repeatedly carrying food into an

arbor vitae swamp in western Montmorency County (Sec 30, T 32 N, R I E) The nest could not be found, though when the locality was approached the bird scolded violently and even dived at the intruder The bird was collected and proved to be a breeding female

Accipiter cooperi (Bonap) Cooper's hawk — One was seen south of Charlevoix by N A Wood on August 30, 1922

Astur atricapillus atricapillus (Wilson) Goshawk — W E Hastings collected an adult male near Norwood, November 23, 1910

Buteo borealis borealis (Gmelin) Red-tailed hawk — One was seen in Chandler Township, August 11, 1923, and W E Hastings noted one near Norwood, June 21, 1922

Haliæetus leucocephalus leucocephalus (Linn) Bald eagle — One was observed at Norwood November 21, 1920, by W E Hastings It was also seen near Thumb Lake on August 15, 1923, by L R Dice On July 26 a nest was found on Marion Island It was situated about sixty feet from the ground in a great maple on the highest part of the wooded bluff which extends along the west side of the island The pair consisted of an adult and an immature bird

Cherchneis sparveria sparveria (Linn) Sparrow hawk — Only three were seen in the county during the whole summer One seen on July 23 was being attacked by a kingbird and was carrying in its claws, with no apparent difficulty, a bird of the size and appearance of a kingbird, but which could not be surely identified

Pandion haliaetus carolinensis (Gmelin) Osprey — Observed near Norwood on June 21, 1922, by W E Hastings A nest of this species was found July 9, 1923, in the pine-barren country in the western part of Montmorency County (Sec 18, T 32 N, R I E) by A S Warthin, Jr There were three well feathered young

Strix varia varia Barton, Barred owl — One was seen by A S Warthin, Jr, June 23, 1923, in a small patch of second-growth fir and spruce forest south of Boyne Falls On July 30 a young one well able to fly but still in the down

was collected by L R Dice in the hardwood forest just north of Thumb Lake

Bubo virginianus virginianus (Gmelin) Great horned owl — Reported by W E Hastings near Norwood, November 21, 1910

Nyctea nyctea (Linn) Snowy owl — W E Hastings collected one near Norwood on November 21, 1910

Coccyzus erythropthalmus (Wilson) Black-billed cuckoo — But few were seen during the summer of 1923

Ceryle alcyon alcyon (Linn) Kingfisher — The kingfisher was common along the many small streams, but rather less so on the inland lakes A bird of strong flight, it is much given to wandering over the surrounding country, often far from any water It was common around the shores of Marion Island, nesting there in the high banks on the east shore

Dryobates villosus villosus (Linn) Hairy woodpecker — Occasional individuals were seen in a great variety of habitats, but only in the arbor vitae swamps was the species seen with any frequency

Dryobates pubescens medianus (Swains) Downy woodpecker — Fairly common and of very wide distribution Found practically wherever there were trees

Picoides arcticus (Swains) Arctic three-toed woodpecker — Seen near Norwood on November 21, 1910, by W E Hastings

Sphyrapicus varius varius (Linn) Sapsucker — One seen by A S Warthin, Jr , south of Boyne Falls on August 8, 1923, was the only specimen seen during the summer N A Wood saw one near Charlevoix, August 27, 1922

Phlœotomus pileatus abieticola (Bangs) Pileated woodpecker — A number were seen and heard in the hardwood forest north of Thumb Lake They were very shy and hard to approach

Melanerpes erythrocephalus (Linn). Red-headed woodpecker. — W E Hastings noted this species near Charlevoix on June 14, 1923, but strangely enough not a single

bird was seen by any of our party in Charlevoix County during the summer, though they were found in some numbers along the roadsides a few miles south in Antrim and Otsego counties near Elmira They were also numerous in beech and jack pine growths ten miles east of Vanderbilt, Otsego County

COLAPTES AURATUS LUTEUS (Bangs) Flicker — Abundant in dry brush, common in pasture, arbor vitae swamp, and aspen, numerous in orchard, swamp brush, pine barren, second-growth hardwood forest, edificarian, dune heath, and ruderal, few in the cultivated field habitat

The flicker is by far the most wide-ranging and adaptable woodpecker of the region and is therefore the most abundant It was commonly seen in the pastures indulging in its well-known taste for ants, and in the latter part of the summer it showed a great fondness for the wild cherries and the berries of the dogwood

ANTROSTOMUS VOCIFERUS VOCIFERUS (Wilson) Whippoorwill — Heard calling in numbers every evening through the second week of July, 1923 After that, single birds only were heard on July 29 and August 5 and 25 It was seen and numbers were heard calling in the young jack pine growth near Black River, eastern Montmorency County July 9–14, 1923 Occasionally here, as in Charlevoix County, it was heard in the very early morning

CHORDEILES VIRGINIANUS VIRGINIANUS (Gmelin) Nighthawk — A common summer resident throughout Charlevoix County In Antrim County the first of the migrating flocks in the fall of 1923 were seen a few miles northwest of Elmira on August 26 During the late afternoon of August 31, 1923, considerable numbers were observed in Otsego County about four miles south of Elmira, flying rapidly to the southward They all seemed to take exactly the same direction (about SSE) as though following a definite route

CHÆTURA PELAGICA (Linn) Chimney swift — Seen in small numbers and rather infrequently, but showing a rather de-

cided preference for the region just above the tree tops of the hardwood forest

ARCHILOCHUS COLUBRIS (Linn) Ruby-throated humming-bird — A number of hummingbirds were seen in Charlevoix County especially around dwellings and gardens and in the second-growth hardwood forest

TYRANNUS TYRANNUS (Linn) Kingbird — Abundant in ruderal, orchard, and dry brush, common in edificarian, cultivated field, numerous in aspen The kingbird wanders occasionally into other habitats, but its typical environment in Charlevoix County is fairly well shown by the foregoing list It was decidedly more abundant than in the southern part of the state A number of nests were found These were usually placed in the bushes by the roadside, but one was found on a small stump in the center of Boyne Falls mill-pond In the vicinity of Boyne Falls, nests were found in which the eggs hatched July 13 and 18 Another with half-grown young was located on July 29 and the young in a fourth left on July 4 The eggs in one of these hatched after fifteen days incubation In the area of desolate cut-over land east of Vanderbilt, Otsego County, this was a very abundant bird On July 10 two nests here had fully grown young

MYIARCHUS CRINITUS (Linn) Crested flycatcher — Probably a rare summer resident Noted near Charlevoix June 14, 1923, by W E Hastings, and at Deer Lake, June 30 A male was collected in Otsego County in an orchard four miles south of Elmira on August 28

SAYORNIS PHŒBE (Lath) Phœbe — A common nesting bird around the farm buildings and under bridges Nests with newly hatched young were seen July 2 and 4, 1923

NUTTALLORNIS BOREALIS (Swains) Olive-sided flycatcher — N A Wood saw one near Charlevoix on August 16, 1922

MYIOCHANES VIRENS (Linn) Wood pewee — This species occurs rather sparingly in the hardwood forest

EMPIDONAX MINIMUS (W M & S F Baird) Least flycatcher — Seen twice in Boyne Valley Township. On August 4,

1923, one was collected in an arbor vitae swamp (L R Dice) and August 16 one was seen in the second growth hardwood (A S Warthin, Jr)

OTOCORIS ALPESTRIS PRATICOLA (Henshaw) Prairie horned lark — A common breeding bird all over Charlevoix County in pastures and cultivated fields

CYANOCITTA CRISTATA CRISTATA (Linn) Blue jay — Rather numerous in all kinds of wooded country and especially so in the arbor vitae swamps The stomach of one collected August 2 contained one large sawfly, a leaf-hopper, and some fragments of beetles

CORVUS BRACHYRHYNCHOS BRACHYRHYNCHOS Brehm Crow — A numerous and wide-ranging bird

DOLICHONYX ORYZIVORUS (Linn) Bobolink — A numerous breeding bird in the alfalfa and clover fields of Charlevoix County

MOLOTHRUS ATER ATER (Bodd) Cowbird — Especially numerous in pastures, but found practically everywhere The first large flock in 1923 was seen on June 30, when a group of over two hundred appeared near Boyne Falls

AGELAIUS PHOENICEUS PHOENICEUS (Linn) Red-winged blackbird — Because of the almost complete lack of suitable marsh land in Charlevoix County but few of these birds are to be found The first wandering flock in 1923 was seen near Thumb Lake on July 21 A single nest with two eggs was located at the Boyne Falls mill-pond on June 23

STURNELLA MAGNA MAGNA (Linn) Meadow-lark — Common in cultivated land A young one just out of the nest was found July 18, 1923, near Boyne Falls by A S Warthin, Jr

ICTERUS GALBULA (Linn) Baltimore oriole — A male was seen near Boyne Falls on June 30, 1920 Noted also near Charlevoix on June 14, 1923, by W E Hastings

QUISCALUS QUISCULA ÆNEUS Ridgway Bronzed grackle — This bird is in Charlevoix County almost confined to the neighborhood of water It was frequently seen feeding on the exposed mud along the shores of streams or lakes and was

rarely seen elsewhere The first large flock of grackles appeared July 29, 1923

CARPODACUS PURPUREUS PURPUREUS (Gmelin) Purple finch — W E Hastings reports this species abundant near Norwood on November 23, 1910 We saw none in Charlevoix County during the summer, but N A Wood noted one in a cedar thicket near Charlevoix on August 24, 1922

ACANTHIS LINARIA LINARIA (Linn) Redpoll - W E Hastings found "large flocks" of redpolls near Norwood on November 21, 1910

ASTRAGALINUS TRISTIS TRISTIS (Linn) Goldfinch — A common resident in the open country On November 23, 1910, W E Hastings found "large flocks" near Norwood "feeding on the seeds of the hemlock "

PASSER DOMESTICUS (Linn) English sparrow — Common in Charlevoix County, but confined to the towns and to the farmyards

PLECTROPHENAX NIVALIS NIVALIS (Linn) Snow bunting — W E Hastings reports large flocks at Norwood, November 21, 1910

POOECETES GRAMINEUS GRAMINEUS (Gmelin) Vesper sparrow — This was the commonest sparrow in Charlevoix County and was always to be found in the pastures and cultivated fields A full grown young bird was found dead near Boyne Falls on June 29, 1923

PASSERCULUS SANDWICHENSIS SAVANNA (Wilson) Savanna sparrow — Seen first in an alfalfa field two miles south of Boyne Falls on June 26, 1923 A female collected there on June 27 contained a partly developed egg A male was seen singing at the same place and on July 2 two singing males were located there As these birds were always seen at exactly the same spot, it seems certain that they were breeding, though no nest was found

ZONOTRICHIA ALBICOLLIS (Gmelin) White-throated sparrow — Numerous in the arbor vitae swamps of Charlevoix County, where it evidently bred, but it was not noted elsewhere

SPIZELLA PASSERINA PASSERINA (Bech) Chipping sparrow —

Common in cultivated field, pasture, edificarian, numerous in orchard, ruderal, dry brush

A common breeding bird Young out of the nest were seen on June 22, 1923, and a nest with newly hatched young was found on July 2

SPIZELLA PUSILLA PUSILLA (Wilson) Field sparrow — None were seen in 1923 N A Wood, however, reports seeing two near Charlevoix in the latter part of August, 1922

JUNCO HYEMALIS HYEMALIS (Linn) Junco — A pair collected two miles south of Boyne Falls on August 3, 1923, were the only ones seen

MELOSPIZA MELODIA MELODIA (Wilson) Song sparrow — A common breeding bird of very general distribution, though rarely found far from water A nest found in a tamarack bog on July 29, 1923, contained young about three days old

PIPILO ERYTHROPTHALMUS ERYTHROPTHALMUS (Linn) Chewink — Widely distributed and found rather commonly wherever there is much brush or undergrowth It was particularly abundant in the arbor vitae swamps The stomach of a female collected south of Boyne Falls on August 3, 1923, contained a small rhynchophorid beetle and a locust (*Camnula pellucida*) The few found on Marion Island were all deep in the hardwood forest in the central part of the island

CARDINALIS CARDINALIS CARDINALIS (Linn) Cardinal — N A Wood records one near Charlevoix on August 18, 1922

HEDYMELES LUDOVICIANUS (Linn) Rose-breasted grosbeak — But three were seen during the summer

PASSERINA CYANEA (Linn) Indigo bunting — Rather numerous, along the roadsides where the males were frequently seen, singing from the fences and telephone wires The stomach of a breeding male collected south of Boyne Falls on August 3 contained a locust (*Camnula pellucida*)

PIRANGA ERYTHROMELAS Vieill Scarlet tanager — A common and characteristic breeding bird of the hardwood forest

PROGNE SUBIS SUBIS (Linn) Purple martin — A pair about a

farm near Boyne Falls and a few pairs nesting in Boyne City were the only ones seen in 1923

HIRUNDO ERYTHROGASTRA Bodd Barn swallow — Numerous about the buildings and fields of most farms

IRIDOPROCNE BICOLOR (Vieill) Tree swallow — Less numerous than the preceding Two nests were found in fence posts on a farm south of Boyne Falls The eggs in one hatched June 30 and the young left nineteen days later The eggs in the other hatched July 4, but only one of the five young survived The male birds were never seen near either nest

RIPARIA RIPARIA (Linn) Bank swallow — A colony of four or five pairs nested in a roadside bank near Boyne Falls On June 27, 1923, the young in these nests were found to be pretty well feathered, probably about two weeks old The only others seen were along the sandy shore of Lake Michigan at Fisherman's Island, where during the week of August 6–10 flocks of a hundred or so were seen feeding

BOMBYCILLA CEDRORUM Vieill Cedar waxwing — Rather scarce everywhere, but least so in the arbor vitae swamps The stomach of a female collected in an arbor vitae swamp August 2 contained seven cherries, eight beetles (Pythidae?), three locusts (*Melanophus mexicanus atlanis*), one sawfly larva and other insect fragments

LANIUS LUDOVICIANUS MIGRANS W Palmer Migrant shrike — Three were seen in Norwood Township in the first week in August The stomach of a male collected August 1 contained a Carolina locust (*Dissosteira carolina*)

VIREOSYLVA OLIVACEA (Linn) Red-eyed vireo — A common summer resident confined usually to the hardwood growth, though occasionally found in other places, such as clumps of poplar, etc

MNIOTILTA VARIA (Linn) Black and white warbler — Numerous in the arbor vitae swamps, and evidently breeding there For, while no nests were found, a number of males were seen in June singing continually from certain perches, and these birds showed much anxiety over the presence of intruders

VERMIVORA RUFICAPILLA RUFICAPILLA (Wilson) Nashville warbler — N A Wood writes "Not rare in cedar and poplar thickets at the 'Loeb Farms' about two miles southeast of Charlevoix Several seen on August 24, 1922" The bird doubtless breeds here

DENDROICA AESTIVA AESTIVA (Gmelin) Yellow warbler — A single male seen in Boyne Falls on June 21 was the only bird noted during the summer This rarity of what is usually such a common bird is very difficult to explain

DENDROICA CÆRULESCENS CÆRULESCENS (Gmelin) Black-throated blue warbler — An adult male was collected in the hardwood forest north of Thumb Lake on August 11, 1923 N A Wood noted one near Charlevoix August 30, 1922

DENDROICA CORONATA CORONATA (Linn) Myrtle warbler — A male was collected in an arbor vitae swamp at Susan Lake on August 23, 1923

DENDROICA MAGNOLIA (Wilson) Magnolia warbler — One seen south of Boyne Falls on June 27, 1923 (A S Warthin, Jr)

DENDROICA STRIATA (J B Forster) Black-poll warbler — One seen in Boyne Valley Township on August 16, 1923 (A S Warthin, Jr)

DENDROICA FUSCA (Müller) Blackburnian warbler — On July 16, 1923, a male was seen at the edge of a small tamarack bog just north of Thumb Lake Two days later a female was noted at the same spot

DENDROICA VIRENS (Gmelin) Black-throated green warbler — Not very numerous Doubtless a summer resident

DENDROICA VIGORSI (Aud) Pine warbler — N A Wood saw one near Charlevoix on August 15, 1922

SEIURUS AUROCAPILLUS (Linn) Oven-bird — Except for the redstart, this is the most abundant warbler in the county It was very abundant in every piece of hardwood visited and only less so in the other types of growth where the cover was thick enough A nest found by T H Hubbell in the hardwood forest north of Thumb Lake contained a half-grown young cowbird on July 19

OPORORNIS PHILADELPHIA (Wilson) Mourning warbler — An

adult male was taken on August 3, 1923, in a mouse trap set in a dry brushy clearing south of Boyne Falls

GEOTHLYPIS TRICHAS TRICHAS (Linn) Maryland yellow-throat — A locally numerous summer resident in damp thickets

WILSONIA CANADENSIS (Linn) Canada warbler — A few were seen in June and early July in arbor vitae swamps, where it evidently bred

SETOPHAGA RUTICILLA (Linn) Redstart — The redstart was an abundant summer resident It was the most abundant warbler and was very wide-spread, though found most frequently in second-growth hardwood forest

DUMETELLA CAROLINENSIS (Linn) Catbird — Rather few and local in Charlevoix County

TOXOSTOMA RUFUM (Linn) Brown thrasher — Less common than the preceding species

TROGLODYTES AEDON AEDON Vieill House wren — Not very abundant, but extremely wide-spread A nest with eggs was found near Boyne Falls on June 30, 1923, and a nest in Chandler Township contained on August 11 four young ready to leave the nest

NANNUS HIEMALIS HIEMALIS (Vieill) Winter wren — During June and July, 1923, winter wrens were frequently heard singing in the arbor vitae swamps, but the birds were extremely hard to locate in the dense tangle, because of the ventriloquistic quality of their song

SITTA CAROLINENSIS CAROLINENSIS Lath White-breasted nuthatch — One was seen in the hardwood forests north of Thumb Lake on July 1, 1923

SITTA CANADENSIS Linn Red-breasted nuthatch — One noted July 5, 1923, in an arbor vitae swamp south of Boyne Falls

PENTHESTES ATRICAPILLUS ATRICAPILLUS (Linn) Chickadee — Numerous

REGULUS SATRAPA SATRAPA Lich Golden-crowned kinglet — A pair were found in an arbor vitae swamp south of Boyne Falls on July 4, 1923 Both birds scolded continually and seemed to have a nest near by, but it could not be found The male was collected

Hylocichla mustelina (Gmelin) Wood thrush — None seen in Charlevoix County A male was collected August 31, 1923, in the hardwood forest four miles south of Elmira in Otsego County

Hylocichla fuscescens fuscenscens (Steph) Veery — A common summer resident especially in the hardwood forest

Hylocichla guttata pallasi (Cabanis) Hermit thrush — W E Hastings found this species near Norwood June 21, 1922

Planesticus migratorius migratorius (Linn) Robin — Common everywhere in the open cultivated country, especially around the farms The young in one nest left July 3

Sialia sialis sialis (Linn) Bluebird — A common nesting bird in the cultivated country

Ann Arbor, Michigan

INDEX OF AUTHORS AND SUBJECTS

VOL V SOURCES OF THE SYNOPTIC GOSPELS By Rev Dr Carl S Patton, First Congregational Church, Los Angeles, California Pp xiii + 263 $1 30 net

---

Size, 28 × 18 5 cm 4to

VOL VI ATHENIAN LEKYTHOI WITH OUTLINE DRAWING IN GLAZE VARNISH ON A WHITE GROUND By Arthur Fairbanks, Director of the Museum of Fine Arts, Boston With 15 plates, and 57 illustrations in the text Pp viii + 371 Bound in cloth $4 00 net

VOL. VII ATHENIAN LEKYTHOI WITH OUTLINE DRAWING IN MATT COLOR ON A WHITE GROUND, AND AN APPENDIX ADDITIONAL LEKYTHOI WITH OUTLINE DRAWING IN GLAZE VARNISH ON A WHITE GROUND By Arthur Fairbanks With 41 plates Pp x + 275 Bound in cloth $3 50 net

VOL VIII THE OLD TESTAMENT MANUSCRIPTS IN THE FREER COLLECTION By Henry A Sanders, University of Michigan With 9 plates showing pages of the Manuscripts in facsimile Pp viii + 357 Bound in cloth $3 50 net

Parts Sold Separately in Paper Covers

Part I THE WASHINGTON MANUSCRIPT OF DEUTERONOMY AND JOSHUA. With 3 folding plates Pp vi + 104 $1 25 net

Part II THE WASHINGTON MANUSCRIPT OF THE PSALMS With 1 single plate and 5 folding plates Pp viii + 105–349 $2 00 net

VOL IX THE NEW TESTAMENT MANUSCRIPTS IN THE FREER COLLECTION By Henry A Sanders, University of Michigan With 8 plates showing pages of the Manuscripts in facsimile Pp x + 323 Bound in cloth $3 50

Parts Sold Separately in Paper Covers

Part I THE WASHINGTON MANUSCRIPT OF THE FOUR GOSPELS With 5 plates. Pp vii + 247 $2 00 net

Part II THE WASHINGTON MANUSCRIPT OF THE EPISTLES OF PAUL. With 3 plates. Pp ix + 251–315 $1 25 net

VOL. X THE COPTIC MANUSCRIPTS IN THE FREER COLLECTION By William H Worrell, Hartford Seminary Foundation With 12 plates Pp xxvi + 396 Bound in cloth $4 75 net

Parts Sold Separately in Paper Covers

Part I THE COPTIC PSALTER. The Coptic text in the Sahidic Dialect, with an Introduction, and with 6 plates showing pages of the Manuscript and Fragments in facsimile Pp xxvi + 112 $2 00 net

Part II A HOMILY ON THE ARCHANGEL GABRIEL BY CELESTINUS, BISHOP OF ROME, AND A HOMILY ON THE VIRGIN BY THEOPHILUS, ARCHBISHOP OF ALEXANDRIA, FROM MANUSCRIPT FRAGMENTS IN THE FREER COLLECTION AND THE BRITISH MUSEUM The Coptic Text with an Introduction and Translation, and with 6 plates showing pages of the Manuscripts in facsimile Pp 113–396. $2 50 net

THE MACMILLAN COMPANY

Publishers 64–66 Fifth Avenue New York

VOL XI CONTRIBUTIONS TO THE HISTORY OF SCIENCE

Part I ROBERT OF CHESTER'S LATIN TRANSLATION OF THE ALGEBRA OF AL-KHOWARIZMI With an Introduction, Critical Notes, and an English Version By Louis C Karpinski, University of Michigan With 4 plates showing pages of manuscripts in facsimile, and 25 diagrams in the text Pp vii + 164 Paper covers $2 00 net

Part II THE PRODROMUS OF NICOLAUS STENO'S LATIN DISSERTATION CONCERNING A SOLID BODY ENCLOSED BY PROCESS OF NATURE WITHIN A SOLID Translated into English by John G Winter, University of Michigan, with a Foreword by Professor William H Hobbs With 7 plates Pp vii + 169–283 Paper covers $1 30 net

Part III VESUVIUS IN ANTIQUITY Passages of Ancient Authors, with a Translation and Elucidations By Francis W Kelsey Illustrated (*In preparation*)

VOL XII STUDIES IN EAST CHRISTIAN AND ROMAN ART By Charles R Morey, Princeton University, and Walter Dennison With 67 plates (10 colored) and 91 illustrations in the text Pp xiii + 175 $4 75 net

Parts Sold Separately

Part I EAST CHRISTIAN PAINTINGS IN THE FREER COLLECTION By Charles R Morey With 13 plates (10 colored) and 34 illustrations in the text Pp xiii + 86 Bound in cloth $2 50 net

Part II A GOLD TREASURE OF THE LATE ROMAN PERIOD B Walter Dennison With 54 plates and 57 illustrations in the text Pp 89–175 Bound in cloth $2 50 net

VOL XIII DOCUMENTS FROM THE CAIRO GENIZAH IN THE FREER COLLECTION Text, with Translation and an Introduction by Richard Gottheil, Columbia University (*In press*)

VOL XIV TWO STUDIES IN LATER ROMAN AND BYZANTINE ADMINISTRATION By Arthur E R Boak and James E Dunlap, University of Michigan Pp x + 324 Bound in cloth $2 25 net

Parts Sold Separately in Paper Covers

Part I THE MASTER OF THE OFFICES IN THE LATER ROMAN AND BYZANTINE EMPIRES By Arthur E R Boak Pp x + 160 Paper covers $1 00 net

Part II THE OFFICE OF THE GRAND CHAMBERLAIN IN THE LATER ROMAN AND BYZANTINE EMPIRES By James E Dunlap Pp 165–324 $1 00 net

VOL XV GREEK THEMES IN MODERN MUSICAL SETTINGS By Albert A Stanley, University of Michigan With 10 plates Pp xxii + 385 Bound in cloth $4.00 net

Parts Sold Separately in Paper Covers

Part I INCIDENTAL MUSIC TO PERCY MACKAYE'S DRAMA OF SAPPHO AND PHAON Pp 1–68 $0 90 net

THE MACMILLAN COMPANY

Publishers **64–66 Fifth Avenue** **New York**

Part II MUSIC TO THE ALCESTIS OF EURIPIDES WITH ENGLISH TEXT Pp 71–120 $0 80 net

Part III MUSIC TO THE IPHIGENIA AMONG THE TAURIANS BY EURIPIDES, WITH GREEK TEXT Pp 123–190 $0 75 net

Part IV TWO FRAGMENTS OF ANCIENT GREEK MUSIC Pp 217–225 $0 30 net

Part V MUSIC TO CANTICA OF THE MENAECHMI OF PLAUTUS Pp 229–263 $0 60 net

Part VI ATTIS A SYMPHONIC POEM Pp 265–383 $1 00 net

VOL XVI NICOMACHUS OF GERASA INTRODUCTION TO ARITHMETIC Translated into English by Martin Luther D'Ooge, with Studies in Greek Arithmetic by Frank Egleston Robbins and Louis C Karpinski (*In press*)

VOLS XVII, XVIII, XIX, XX ROYAL CORRESPONDENCE OF THE ASSYRIAN EMPIRE Translated into English, with a transliteration of the text and a Commentary By Leroy Waterman, University of Michigan (*In press*)

VOL XXI THE PAPYRUS MINOR PROPHETS IN THE FREER COLLECTION AND THE BERLIN FRAGMENT OF GENESIS By Henry A Sanders, University of Michigan, and Carl Schmidt, University of Berlin (*In press*)

FACSIMILES OF MANUSCRIPTS

Size, 40 5 × 35 cm

FACSIMILE OF THE WASHINGTON MANUSCRIPT OF DEUTERONOMY AND JOSHUA IN THE FREER COLLECTION With an Introduction by Henry A Sanders Pp x, 201 heliotype plates The University of Michigan Ann Arbor, Michigan, 1910

Limited edition, distributed only to Libraries, under certain conditions A list of Libraries containing this Facsimile is printed in *University of Michigan Studies, Humanistic Series* Volume VIII pp 351–353

Size, 34 × 26 cm

FACSIMILE OF THE WASHINGTON MANUSCRIPT OF THE FOUR GOSPELS IN THE FREER COLLECTION With an Introduction by Henry A Sanders Pp x, 372 heliotype plates and 2 colored plates The University of Michigan. Ann Arbor, Michigan, 1912

Limited edition distributed only to Libraries, under certain conditions A list of Libraries containing this Facsimile is printed in *University of Michigan Studies Humanistic Series*, Volume IX pp 317–320

SCIENTIFIC SERIES

Size, 28 × 18 5 cm 4° Bound in Cloth

VOL I THE CIRCULATION AND SLEEP By John F Shepard, University of Michigan Pp ix + 83, with an Atlas of 63 plates, bound separately Text and Atlas, $2 50 net

VOL. II STUDIES ON DIVERGENT SERIES AND SUMMABILITY By Walter B Ford, University of Michigan Pp xi + 194 $2 50

VOL IV (1924), PART I With 27 plates, 22 text figures and 3 maps Pp xi + 631 $3 00 net Bound in paper, $2 25 net

VOL IV (1924), PART II A KEY TO THE SNAKES OF THE UNITED STATES, CANADA AND LOWER CALIFORNIA By Frank N Blanchard With 78 text figures Pp xiii + 65 Cloth, $1 75

CONTRIBUTIONS FROM THE MUSEUM OF GEOLOGY

VOLUME I

THE STRATIGRAPHY AND FAUNA OF THE HACKBERRY STAGE OF THE UPPER DEVONIAN By Carroll Lane Fenton and Mildred Adams Fenton With 45 plates, 9 text figures and one map Pp xi + 260 Cloth $2 75

VOLUME II

(*All communications relative to the Numbers of Volume II should be addressed to the Librarian, General Library, University of Michigan*)

No 1 A Possible Explanation of Fenestration in the Primitive Reptilian Skull, with Notes on the Temporal Region of the Genus Dimetrodon, by E C Case Pp 1–12, with five illustrations $0 30

No 2 Occurrence of the Collingwood Formation in Michigan, by R Ruedemann and G M Ehlers Pp 13–18 $0 15

No 3 Silurian Cephalopods of Northern Michigan, by Aug F Foerste Pp 19–104, with 17 plates $1 00

(*All communications relative to the volumes listed below should be addressed to the Librarian, General Library, University of Michigan*)

HISTORICAL STUDIES

(Published under the direction of the Department of History, 1911–1913)

VOL I A HISTORY OF THE PRESIDENT'S CABINET By Mary Louise Hinsdale Pp ix + 355 Cloth $2 00

VOL II ENGLISH RULE IN GASCONY, 1199–1259, WITH SPECIAL REFERENCE TO THE TOWNS By Frank Burr Marsh Pp xi + 178 Cloth $1 25

VOL III THE COLOR LINE IN OHIO, A HISTORY OF RACE PREJUDICE IN A TYPICAL NORTHERN STATE By Frank Uriah Quillan Pp xvi + 178 Cloth $1 50

CATALOGUE OF THE STEARNS COLLECTION OF MUSICAL INSTRUMENTS (Second edition) By Albert A Stanley With 40 plates Pp 276 $4 00